JUACEP Summer Program 2017 at Nagoya University

Japan-US Advanced Collaborative Education Program

Nagoya University

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(a) Overview

Summer 10-week course 2017 for the students of University of Michigan and UCLA

Duration: June 20 – August 30, 2017
Research presentations: The 20th JUACEP Workshop on August 29, 2017

This program was designed for graduate students at University of Michigan and at University of California, Los Angeles.

Each participant chose a laboratory at Nagoya University according to his/her research interest and carried out a research project under the supervisor of the laboratory. At the same time most of them attended the Japanese language class, the hands-on engine model assembly course and some special events organized for the program.

During the program period, they took part in the labs' events such as seminars, sessions, trips, casual parties, and so on. Teaching Assistants (TA) assigned by the program supported the participants not only in researches but also in daily life.

At the end of the program, they submitted the research report to the supervisors and gave the final presentation at the 20th JUACEP Workshop. Based on the evaluation of the report and the presentation by each supervisor, the participants earned 2-3 credits, which will be transferred as graduation credits for UM students.

All participants at 20th Workshop at NIC Hall on August 29, 2017

(b) Participants

	Name	Adviser & Teaching Assistant at NU
1	**Brian Wen CHANG** Electrical and Computer Engineering Univ. of Michigan	**Prof. Fumihito ARAI** **TA: Shunnya ADACHI** Micro-Nano Mechanical Science and Engineering
2	**Hao-En CHANG** Aerospace Engineering Univ. of Michigan	**Assoc. Prof. Ken Matsuoka** **TA: Keisuke GOTO** Aerospace Engineering
3	**Muzhi ZHU** Mechanical Engineering Univ. of Michigan	**Prof. Tatsuya SUZUKI** **TA: Ikumi NAWATA** Mechanical Systems Engineering
4	**Chenfan LIAN** Mechanical Engineering Univ. of Michigan	**Prof. Yoji YAMADA** **TA: Eugene KIM** Mechanical Systems Engineering
5	**Erik Harrison KRAMER** Mechanical and Aerospace Engineering UCLA	**Prof. Yoji YAMADA** **TA: Yusuke FUKUI** Mechanical Systems Engineering
6	**Jia WANG** Materials Science and Engineering UCLA	**Prof. Hiroshi AMANO** **TA: Shigeyoshi USAMI** Electronics
7	**Zhiwei LIU** Materials Science and Engineering UCLA	**Prof. Makoto KOBASHI** **TA: Youta AOKI** Materials Process Engineering
8	**Yizhen ZHANG** Materials Science and Engineering UCLA	**Prof. Makoto KOBASHI** **TA: Seunggwang KIM** Materials Process Engineering

Japanese Course Instructors

Ms. Sumie YASUI
TA: Naoki KAMIMURA

Coordinators of Partner Universities

Prof. Katsuo KURABAYASH
Mechanical Engineering, University of Michigan

Prof. Jenn-Ming YANG
Materials Science and Engineering, UCLA

JUACEP Members

Prof. Noritsugu UMEHARA
Micro-Nano Mechanical Science and Engineering

Prof. Yang JU
Micro-Nano Mechanical Science and Engineering

Assoc. Prof. Yasumasa ITO
Mechanical Systems Engineering

Tomoko KATO
Administrative staff

(c) JUACEP Summer Program 2017 Schedule

Day	Date		8:45-10:15	10:30-12:00		13:00-14:30	14:45-16:00	16:15-
1	June 19	Mon	Arrival at International Residence Yamate					
2	June 20	Tue	10:20 Reception, 11:00 Orientation @ ESB, ES Hall		Welcome Lunch	13:00 Stipend @Account office	Lab introduction @ each Lab	
3	June 21	Wed	Research @ each Lab					
4	June 22	Thu	9:10 Japanese Class① @ EB-N, IB101			Research @ each Lab		
5	June 23	Fri	Research @ each Lab					
6	June 24	Sat						
7	June 25	Sun						
8	June 26	Mon	Research @ each Lab					
9	June 27	Tue	9:10 Japanese Class② @EB-N, IB101			Research @ each Lab		
10	June 28	Wed	Research @ each Lab					
11	June 29	Thu	9:10 Japanese Class③ @EB-N, IB101					
12	June 30	Fri	10:30 JUACEP Seminar @EB-2 221					16:00 Meet-up @EB-2,347
13	July 1	Sat						
14	July 2	Sun						
15	July 3	Mon	Research @ each Lab			Research @ each Lab		
16	July 4	Tue	9:10 Japanese Class④ @EB-N, IB101			13:00 Hands-on Exercise A @ EB-N, Creation Plaza, 10F		
17	July 5	Wed	Research @ each Lab			Research @ each Lab		
18	July 6	Thu	9:10 Japanese Class⑤ @EB-N, IB101			13:00 Hands-on Exercise B @ EB-N, Creation Plaza, 10F		
19	July 7	Fri	Research @ each Lab			Research @ each Lab		
20	July 8	Sat						
21	July 9	Sun						
22	July 10	Mon	Research @ each Lab					
23	July 11	Tue	9:10 Japanese Class⑥ @EB-N, IB101			Research @ each Lab		
24	July 12	Wed	Research @ each Lab					
25	July 13	Thu	9:10 Japanese Class⑦ @EB-N, IB101			13:00 Stipend @ ES032	Research @ each Lab	
26	July 14	Fri	Field Trip, Meeting at Toyota Auditorium at 9:00am					
27	July 15	Sat						
28	July 16	Sun						
29	July 17	Mon	(Marine day)					
30	July 18	Tue	9:10 Japanese Class⑧ @EB-N, IB101					
31	July 19	Wed				Research @ each Lab		
32	July 20	Thu	Research @ each Lab					
33	July 21	Fri						
34	July 22	Sat						
35	July 23	Sun						
36	July 24	Mon						
37	July 25	Tue	Research @ each Lab					
38	July 26	Wed				Research @ each Lab		
39	July 27	Thu	9:10 Japanese Class⑨ @EB-N, IB101					
40	July 28	Fri	Research @ each Lab					
41	July 29	Sat						
42	July 30	Sun						
43	July 31	Mon	Research @ each Lab					
44	Aug 1	Tue	9:10 Japanese Class Final @EB-N, IB101					
45	Aug 2	Wed				Research @ each Lab		
46	Aug 3	Thu	Research @ each Lab					
47	Aug 4	Fri						
48	Aug 5	Sat						
49	Aug 6	Sun						
50	Aug 7	Mon						
51	Aug 8	Tue				Research @ each Lab		
52	Aug 9	Wed	Research @ each Lab					
53	Aug 10	Thu				13:00 Stipend @ ES032	Research @ each Lab	
54	Aug 11	Fri						
55	Aug 12	Sat						
56	Aug 13	Sun	(Bon Holidays)					
57	Aug 14	Mon						
58	Aug 15	Tue						
59	Aug 16	Wed						
60	Aug 17	Thu	Research @ each Lab			Research @ each Lab		
61	Aug 18	Fri						
62	Aug 19	Sat						
63	Aug 20	Sun						
64	Aug 21	Mon						
65	Aug 22	Tue						
66	Aug 23	Wed	Research @ each Lab			Research @ each Lab		
67	Aug 24	Thu						
68	Aug 25	Fri						
69	Aug 26	Sat						
70	Aug 27	Sun						
71	Aug 28	Mon	Research @ each Lab			Research @ each Lab		
72	Aug 29	Tue				20th Workshop @ NIC Meeting Room, 3F		Farewell Party
73	Aug 30	Wed	Closing session @ each Lab					
74	Aug 31	Thu	Departure from Residence Yamate					

JUACEP event	**Japanese class**	**Stipend payment**	**Holiday**

<2> Classes and Events

(a) Japanese Course Syllabus

(b) The 43rd JUACEP Seminar

(c) Meet-up for JUACEP Students

(d) Hands-on Exercise

(e) Field Trip

(f) Research Internship --Research Reports

(g) The 20th JUACEP Workshop --Presentations

(a) Japanese Course Syllabus

Course name	Japanese Language
Teaching staff	Ms. YASUI Sumie, (TA… KAMIMURA Naoki)
Course period	June 22 – August 1, 2017
Weekly timetable	Tuesday & Thursday,1st (45 min) & 2nd period (90 min) (9：10-11：30)
Classroom	IB 101 Lecture room, 10th floor of IB North Building
Textbook	"GENKI, An Integrated Course in Elementary Japanese" I (The Japan Times) This textbook is a comprehensive approach to developing the four basic language skills (listening, speaking, reading and writing) in order to cultivate overall Japanese-language ability. *Some teaching material will be given in class.
Course Contents	**Course outline** The purpose of this course is to introduce the most essential Japanese words and expressions for everyday life. Students will learn writing system (Hiragana & Katakana), the basic grammar, expressions of Japanese. **Classroom activities** Basic communication skills required in everyday life will be taught by introducing new vocabulary, new grammar, and practicing listening, conversation and role-playings. **Homework and Quiz** You are expected to submit your homework by the deadline. Quizzes will be given every day in class. 1. Hiragana 2. Katakana 3. Dictation 4. Conjugation
Evaluation	1. Homework 20% S=100-90 2. Quizzes 30% A=89-80 3. Oral exam. 50% B=79-70 100% C=69-60 More than 80% attendance is required. F(fail)=59-0 You will be officially awarded 1 credit of Nagoya University.

Course schedule	1. 6/22(Thu) Greeting Expressions, Hiragana 1 Introducing yourself , Noun sentences 1, Occupation, Nationality, Age, Numbers 1-100 2. 6/27(Tue) Classroom expressions, Hiragana 2 Shopping, Noun sentences 2, Price, Numbers 101-1,000,000 3. 6/29(Thu) Hiragana 3 Describing where things are, Locations Placing an order at a restaurant 4. 7/4(Tue) Hiragana 4 Talking about your daily life Verbal sentences 1, Time reference, Adverbs 5. 7/6(Thu) Hiragana 5 Invitations, Suggestions, Desires Verbal sentences 2, Days/Weeks/Months/Years, Counting 6. 7/11(Tue) Katakana 1 Talking about your family Adjectives, Likes or Dislikes, Degree expressions, Family terms 7. 7/13(Thu) Katakana 2 Talking about your week-end, Past tense, Time words 8. 7/18(Tue) Katakana 3 Making a request (Verb-Te-form), Progressive actions, Describing your status 9. 7/27(Thu) Asking permission, Prohibition, Negative request Describing two things Talking about your interests Plain form 10. 8/1(Tue) The Final Examination (speaking)

(b) The 43rd JUACEP Seminar

The 43rd JUACEP Seminar

第 43 回 名古屋大学日米協働教育プログラムセミナー

10:30- Friday, June 30, 2017
Lecture room 221 (2F, Eng.Bldg. II)

Electrokinetic and Nanomechanical Transport of Biomolecules for Ultrasensitive Bio-Detection

Prof. Katsuo Kurabayashi
Associate Chair
Department of Mechanical Engineering
Department of Electrical Engineering
and Computer Science
University of Michigan, U.S.A.

Abstract

On-chip high-throughput, ultrasensitive screening for emerging diagnostic applications and innovative scientific discovery require systems for detecting protein concentrations in the nano- to picomolar range (~ a few molecules per cell). Low volume technology is expected to promise sensitivity, cost, and speed advantages associated with small scales. However, such small scales pose crucial challenges to bio-detection owing to friction against fluid transport at low Reynolds numbers and random motion of molecules. These challenges significantly compromise on-chip nano-biosensors. To address these issues, we have developed integrated microsystems that control mass transport of biomolecules under micro- to nanofluidic environments with AC electroosmosis flow and adenosine triphosphate (ATP)-fueled motor proteins. Our system integrates AC electroosmosis flow-inducing microelectrodes with plasmonic nanoparticle biosensors. Another system implements nanoscale mechanical manipulation of the stochastic motion of motor proteins for protein concentration. Motor proteins are nanometer-scale biomaterials that convert chemical energy stored in ATP into mechanical work. This seminar talk discusses fundamental statistical mechanics, electrodydrodynamics, and mass transport theories, nanomaterial synthesis, and microfabrication that provide the foundations of our technological approaches and their impacts on clinical diagnosis of immune diseases. (Talked in English)

Biography

Katsuo Kurabayashi is Professor of Mechanical Engineering and Electrical Engineering and Computer Science at the University of Michigan, Ann Arbor. He received his BS in Precision Engineering from the University of Tokyo in 1992, and his MS and PhD in Materials Science and Engineering from Stanford University, CA, in 1994 and 1998, respectively. His current research focuses on optofluidics, nanoplasmonic and biomolecular biosensing, and BioMEMS/microsystems for immunology, clinical diagnosis, and analytical chemistry. He received the 2001 NSF Early Faculty Career Development (CAREER) Award, and the Robert Caddell Memorial Award in 2005, the Pi Tau Sigma Outstanding Professor Award in 2007, the Mechanical Engineering Outstanding Achievement Award in 2013 from the University of Michigan, and the Ted Kennedy Family Team Excellence Award in 2015 from the College of Engineering at the University of Michigan.

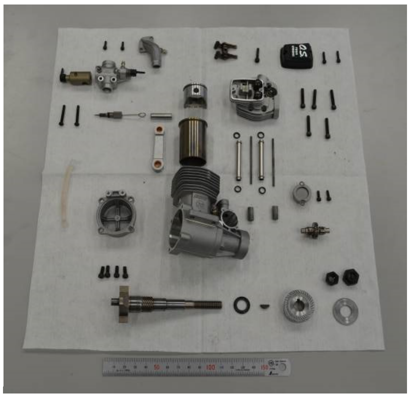
Inquiry: JUACEP Office 日米協働教育プログラム (Ext. 2799)

JUACEP: Japan-US Advanced Collaborative Education Program, Graduate School of Engineering

(c) Meet-up for JUACEP Students

(d) Hands-on Exercise

"Disassembly and Assembly of Internal Combustion Engine"



Group A: July 4, Tue
Hao-En CHANG
Erik KRAMER
Zhiwei LIU
Chenfan LIAN

Group B: July 6, Thu
Brian CHANG
Jia WANG
Muzhi ZHU
Yizhen ZHANG
Arun Muraleedharan*

*G30 student

Time: 13:00 – 16:00

Place: Creation Plaza, 10th floor of IB-North

Staff: Prof. Yasuhiko Sakai, Director of Creation Plaza

Technical staff…Nakakimura, Goto, Saito, Isogai, Adachi and Yamamoto

Contents:

1. Opening remarks
2. Introduction to the basis of the Internal Combustion Engine and other engines
   (History, Characteristics, Operation principle, Demonstration of engines)
3. Disassembling → Assembling → Adjustment
4. Performance test
5. Jet engine demonstration
6. Discussion, questionnaire

(e) Field Trip

Date: July 14, Friday

Escorts: Asst. Prof. Takehiro Hayasaka
Tomoko Kato, JUACEP

Fee: 1,000 yen

Visiting spots:

・Toyota Kaikan Museum
http://www.toyota.co.jp/en/about_toyota/facility/toyota_kaikan/museum/

・Toyota Motor Factory
http://www.toyota.co.jp/en/about_toyota/facility/toyota_kaikan/index.html

・Toyota Commemorative Museum of Industry and Technology
http://www.tcmit.org/english/

・BBQ (dinner) at Meitetsu Building, Nagoya Station

Schedule:

Time	Event	Transportation
9:10	Meeting at Toyoda Auditorium	
9:20	Departure from Nagoya University	Hired bus
10:30	Toyota Kaikan Museum	
11:00	Toyota Factory	
13:00	Leaving Toyota and Lunch in the bus	Hired bus
13:40	Toyota Commemorative Museum of Industry and Technology	
17:00	Leaving the Museum	Hired bus
17:30	BBQ dinner	
19:30	Adjournment at Nagoya Station	Subway

*Schedule above is tentative and may be changed.
*Wear sports shoes for safety of the factory tour.
*Photo is not allowed in the factory.

(f) Research Internship ---Research Reports

PRESSURE CONTROL IN AN EYE MODEL

Brian Chang

Dept. of Electrical Engineering and Computer Science, College of Engineering, University of Michigan
bwchang@umich.edu

Supervisor: Prof. Fumihito Arai

Dept. of Micro-Nano Mechanical Science and Engineering, Graduate School of Engineering, Nagoya University
arai@mech.nagoya-u.ac.jp

ABSTRACT

The purpose of this project is to develop a control model for modelling pressure in an eye model. The eye model can be used to practice certain surgical procedures of the eye, such as *trabeculoplasty* for the treatment of glaucoma. Certain eye surgeries are very complicated due to the risk of damage to some very small structures, such as blood vessels and nerves, making it too great of a risk for inexperienced surgeons to practice directly on patients. To make the simulator reliable, close-to-realistic conditions are desirable. One of the conditions that should be modelled is *intraocular pressure*, or the pressure inside the eye.

Undisclosed

Dependency of spark energy on deflagration-to-detonation transition in a high-speed flow

Hao-En Chang
Department of Aerospace Engineering, University of Michigan
haoencha@umich.edu

Supervisor: Ken Matsuoka
Graduate School of Engineering, Nagoya University
matsuoka@nuae.nagoya-u.ac.jp

ABSTRACT

A novel spark ignition system was proposed and demonstrated for investigating the dependency of spark energy on the enhancement of deflagration-to-detonation transition (DDT), which is critical to improving the operation efficiency of a pulse detonation engine. In this experiment, we supplied a voltage input of 25, 30, 40, and 50V to the spark ignition circuit and estimated the corresponding DDT distance and time from the schlieren images taken throughout the DDT process. The experimental results indicated that the DDT distance and time were not directly dependent on the total energy produced by the spark ignition circuit but rather the instantaneous energy output at the instant of spark initiation.

1 INTRODUCTION

A pulse detonation combustor (PDC) is a propulsive device that burns fuel periodically via repeated self-sustained detonations. It is consisted of a straight tube with a fixed cross-section, in which one end is closed with fuel or gas-feeding lines and spark plugs and the other end open. An internal combustion engine (ICE) motivated by the physics of pulsed detonations is commonly called a pulse detonation engine (PDE). Since the burning temperature in detonation is higher than that in conventional isobaric combustion, the theoretical thermal efficiency of a PDE is higher than that of an ICE [1]. As a result, PDEs have generated substantial interest within the aerospace industry and been widely applied for propulsive applications.

The working of a PDE includes five main processes, which are repeated in the following order: 1) filling of fuel and oxidizer (detonable mixture), 2) ignition and deflagration-to-detonation transition (DDT), 3) propagation of a self-sustained detonation, 4) blowdown of the high-pressure hot burned gas, and 5) purging of the residual low-pressure hot burned gas. Because the time-averaged thrust of a PDC is proportional to its operation frequency, a high-frequency operation is necessary in order to achieve higher engine performance. While it is desirable to shorten each aforementioned process to improve the operation frequency of a PDE, 3) and 4) are exclusively determined by the gas dynamics and the time scale of each process also depends on the composition of the detonable mixture and the length of the PDC. Therefore, the development of new techniques to shorten processes 1), 2), and 5) is crucial for high-performance PDCs[1].

The valveless gas-feeding method has been considered to shorten processes 1) and 5). In the valveless scheme of operation, the high-pressure burned gas generated in the PDC works similarly to valves and interrupt the gas supply to a PDC. This type of valveless PDC is ideal for high-frequency long-time operation because it contains no moving parts and is solely governed by the repeated ignitions. However, one disadvantage of the valveless design is that the detonable mixture is unavoidably diluted by the purging gas, thus leading to a decrease in the specific heat released by combustion and a decrease in the operation frequency due to an increase in the DDT distance and time. As a method to overcome these problems, a newly developed purge method called the liquid-purge method (LIP method) is proposed by Matsuoka et al. In the LIP method, the liquid droplets are injected up until immediately before the onset of detonation. Once detonation occurs, the high-pressure burned gas generated in the PDC interrupts the gas supply and the liquid droplets are vaporized in the burned gas, which is followed by an approximately thousand-fold volume expansion. Therefore, the hot burned gas is cooled and pushed outward, or purged. This purge process will continue until the pressure around the gas-feeding ports drops below the fuel-injection pressure, at which point the fuel and oxidizer will be allowed to flow back into the PDC again. Throughout the purge process with the LIP method, the dilution of detonable mixture in theory does not occur [2].

Several methods to reduce DDT distance and time have already been studied. Kuznetsov et al. suggested that the distance from ignition point to the location of DDT was shortened with increasing initial pressure of static hydrogen-oxygen mixture [3]. Similarly, the installation of flame accelerating mechanisms such as a Shchelkin spiral or orifice plate within the combustor also helps reduce the DDT distance by generating turbulence in the flow. Ciccarelli et al. concluded that when the blockage ratio of the orifice plate was changed from 1% to 30%, the run-up distance reduced by approximately 75-80% [4]. The generation of turbulence will increase the surface area of the flame and thus increase the volumetric burning rate, which means the flow will reach the necessary flame velocity faster to trigger the onset of detonation. Furthermore, Schild et al. investigated the influence of spark energy on detonation initiation in a hydrocarbon-fueled PDE and found that flame front propagated faster at higher spark energies and with more spark locations. In particular, he concluded that initial flame acceleration was 16% faster for the 4-spark, 4 J case when compared to the baseline 1-spark, 1 J case[5].

In this experiment, we developed a new spark ignition system and wanted to understand whether or not the enhancement of DDT could be realized by applying a higher total spark energy to our PDC.

2 DEFLAGRATION-TO-DETONATION TRANSITION

Upon ignition, a large amount of potential energy stored in the chemical bonds of the reactant molecules is released. This introduces significant changes in the thermodynamic and gasdynamic states across the combustion wave. The gradient fields across the wave give rise to the self-sustained propagation of the combustion wave.

There are two types of self-propagating combustion waves: *deflagrations* and *detonations*. Deflagration waves propagate at low subsonic velocities relative to the reactants ahead of them. Because of the subsonic propagation, disturbances downstream can travel upstream and influence the initial state of the reactants. This also suggests the propagation speed of a deflagration wave depends not only on the properties and initial state of the explosive mixture but also on the rear boundary condition behind the wave. Furthermore, a deflagration is an expansion wave that causes a displacement of the reactants ahead of the reaction front. As a result, the deflagration velocity should be treated as the sum of the displacement flow velocity of the reactants and the velocity of the reaction front relative to the reactants [6].

A deflagration wave propagates into the reactants ahead of it via diffusion of heat and mass. The steep temperature and chemical species concentration gradients across the reaction front become the transport mechanisms that eventually help initiate ignition. A deflagration is a type of diffusion wave whose velocity is proportional to the square root of the diffusivity and of reaction rate (which governs the gradients).

On the other hand, a detonation is a supersonic combustion wave across which the thermodynamic states such as temperature and pressure increase drastically. Since the wave is supersonic, the reactants ahead are not disturbed prior to the arrival of the detonation and maintain their initial state. For a freely propagating detonation, the expansion wave behind the detonation front will reduce the pressure and particle velocity to match the rear boundary condition. If the flow is subsonic behind a strong detonation, the expansion wave will be able to penetrate the reaction zone and reduce the detonation. Therefore, a freely propagating detonation must have either a sonic or a supersonic condition behind it. Chapman-Jouguet (CJ) detonations are those with sonic condition behind them, whereas weak detonations require a supersonic condition behind them.

Since there are numerous mechanisms that are involved in the onset of detonation, or DDT, a single general theory has yet been developed to fully describe the phenomenon. Therefore, it is not likely to accurately predict if and when DDT occurs even if the initial and boundary conditions of an explosive mixture are given [6].

The basic conservation equations of mass, momentum, and energy for one-dimensional steady flow across a combustion wave are given by

$$\rho_0 u_0 = \rho_1 u_1, \tag{1}$$

$$p_0 + \rho_0 u_0^2 = p_1 + \rho_1 u_1^2, \tag{2}$$

$$h_0 + \frac{u_0^2}{2} = h_1 + \frac{u_1^2}{2}, \tag{3}$$

By Eq 1 and 2, we obtain the following relation

$$\frac{p_1 - p_0}{v_0 - v_1} = \rho_2^2 u_0^2 = \rho_1^2 u_1^2 = \dot{m}^2, \tag{4}$$

where $v = 1/\rho$ is the specific volume and $\dot{m} = \rho u$ is the mass flux per unit area. For $\dot{m}$ to be real,

$$\frac{p_1 - p_0}{v_0 - v_1} > 0.$$

Therefore, we require that if $p_1 - p_0 > 0$ then $v_0 > v_1$, and if $p_1 - p_0 < 0$ then $v_0 < v_1$. In the case of $p_1 > p_0$, we have the compression solution for detonation waves. For $p_1 < p_0$, we have the expansion solutions for deflagration waves. Moreover, we can simplify Eq 4 further by defining $x = \frac{v_1}{v_0} = \frac{\rho_0}{\rho_1}$ and $y = \frac{p_1}{p_0}$. Then,

$$\dot{m} = \sqrt{(\frac{y-1}{1-x})\frac{p_0}{v_0}}. \tag{5}$$

Because the speed of sound in the upstream flow and the Mach number are

$$c_0 = \sqrt{\frac{\gamma_0 p_0}{\rho_0}} = \sqrt{\gamma_0 p_0 v_0}$$

and

$$M = \frac{u_0}{c_0},$$

Eq.5 can be rewritten as

$$y = (1 + \gamma_0 M_0^2) - (\gamma_0 M_0^2)x. \tag{6}$$

Also known as the *Rayleigh line*, the above equation defines the thermodynamic path in which the transition from state (1, 1) to state (x, y) across the combustion wave takes place.also known as the *Rayleigh line*. The shock Hugoniot curve ($q = 0$) will pass through the initial state $x = y = 1$. For finite value of q, the Hugoniot curve lies above the shock Hugoniot curve and does not intersect with the initial state. Furthermore, when the Rayleigh line is tangent to the Hugoniot curve, the tangency solutions are called *Chapman-Jouquet (CJ)* points. As shown in Figure 1, the upper CJ point corresponds to the CJ detonation solution while the lower CJ point is the CJ deflagration solution.

The gasdynamic theory of detonation is derived based on the conservation laws (the Rankine-Hugoniot relation) and does not consider the physics of the transition process. It links the upstream and downstream equilibrium states across the wave and demonstrates the possible solutions even though the particular solution of interest is not indicated. The CJ criterion, however, provides the extra information for choosing the desired solution, namely, the minimum-velocity solution for tangency of the Rayleigh line to the equilibrium Hugoniot curve [6].

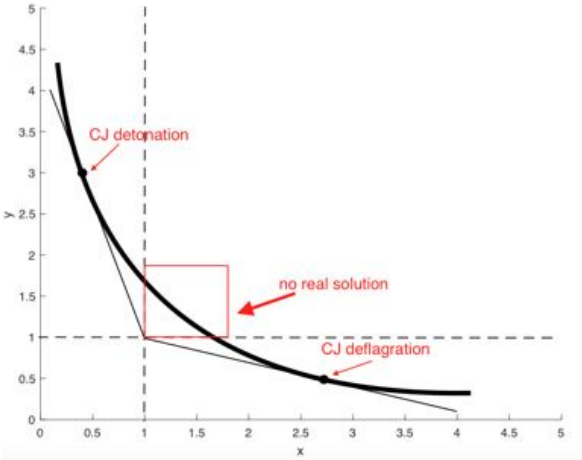


Figure 1: CJ solutions

3 EXPERIMENTAL METHODS

3.1 Spark Ignition Circuit

The spark ignition circuit was assembled accordingly to the circuit scheme developed using LTspice software as shown in Figure 2. See Figure 3 for the spark ignition circuit used in the combustion tests. The components in this circuit included a 100-μF capacitor, 180-Ω, 470-Ω, 250-Ω, 1k-Ω ,10-kΩ resistors, an insulated gate bipolar transistor (IGBT), a diode, and a photocoupler. In particular, the capacitance value was especially important when considering the total spark energy output since $E = \frac{1}{2}CV^2$.

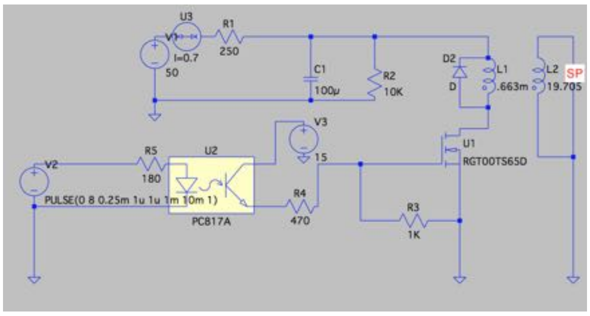


Figure 2: Spark ignition circuit scheme on LTspice

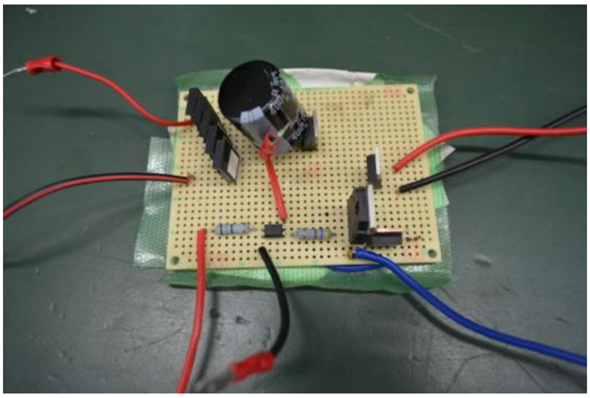


Figure 3: Spark ignition circuit

3.2 PDC Configuration

Figure 4 shows the setup of PDC in this experiment. The PDC was positioned vertically with the oxidizer being supplied from the bottom of the tube in the upward direction. The x-axis is along the tube axis in the direction toward the open-end of the tube, with the origin corresponding to the spark plug position. The fuel was injected perpendicularly to the tube axis into the PDC at $x = -30mm$ from the same side as the position of spark plug. The total length of the combustor was $L_c = 95mm$, which is the distance from the position of spark plug to the open-end of the tube. The combustor had a cross-sectional area of $10mm \times 10mm = 100mm^2$. Additionally, five ion probes were installed along the combustor and oxidizer feedline at $x = -30$, 0, 30, 60, and $90mm$ to measure the flame propagation speed. Two pressure transducers, PCB1 and PCB2, were installed at $x = 60mm$ and $x = 30mm$, respectively, to measure the pressure of combustion flame front.

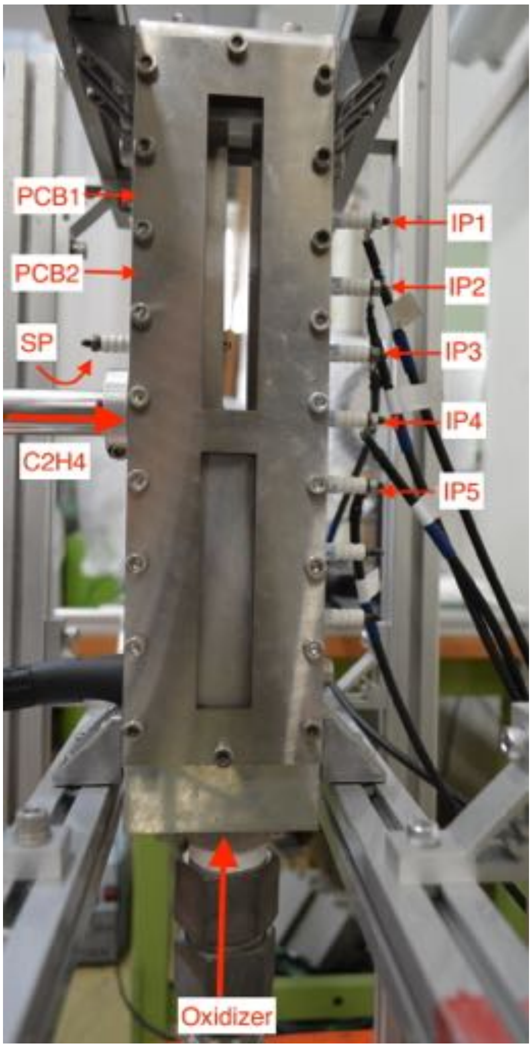


Figure 4: PDC with fuel/oxidizer feeding lines, ion probes (IP), and pressure transducers (PCB)

3.3 Schlieren Flow Visualization

The schlieren photography is a flow visualization technique that makes use of the fact that light rays are bent whenever they come in contact with changes in the density of fluid [7]. In this experiment, the fluid flows inside the PDC were captured using the Photron FASTCAM SA1.1 high-speed camera installed in the schlieren optical measurement system. A total of 63901 schlieren images were recorded in the span of $0.213s$ during each combustion shot. This means the FASTCAM SA1.1 had a film resolution of 0.003333 $ms/frame$. The DDT distance and time can be carefully estimated from the sequence of schlieren photographs run on Photron FASTCAM Viewer software. Figure 5 below shows the experimental setup of schlieren optical measurement system.

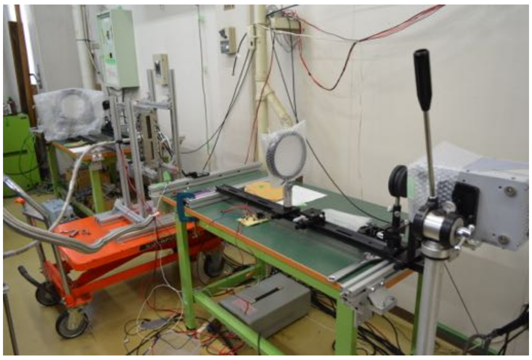


Figure 5: Experimental setup of schlieren optical measurement system

3.4 Experimental Conditions

In this experiment, the only varying parameter was the input voltage to the spark ignition circuit: 25, 30, 40, and 50V, respectively. The capacitance used in the circuit remained the same at 100 μF. The combustion test of each supply voltage was repeated three times so a total of 12 shots were carried out in this experiment. In the end, the total output spark energy for each shot was calculated and the corresponding DDT distance and time were obtained via the sequence of schlieren photographs.

4 RESULTS

4.1 Dependency of Voltage Input on Calculated Output Energy

The output energy due to the spark ignition circuit is calculated as follows:

$$E_{spark} = \sum_{t_0}^{t_f} I_i(V_i - r_{int}I_i)t_i, \quad (7)$$

where I_i and V_i are the current and voltage values of each time index and r_{int} is the internal resistance of spark plug ($\approx 6k\Omega$). Generally, the output spark energy is directly proportional to the capacitance as $E = \frac{1}{2}CV^2$. In this experiment, the total energy was calculated as the energy summed between the first two time indices (t_1, t_2) when $I_1 = I_2 = 0$. The 20-μs and 1-μs energy were calculated as the energy summed over 20μs and 1μs with the initial time chosen as the time index right before the current spikes near to I_{max}. The reason for this choice of initial time was because the energy deposition was considered negligible during which the current was relatively small.

Figure 6 shows the voltage input vs energy output plot, in which the total energy is seen to increase linearly as the voltage increases from 25 to 50V. In the case of 20-μs and 1-μs energy, the linear dependency between voltage and output energy was not as well-observed. Figure 7 is a zoom-in plot of Figure 6 with the y-axis limits set between 0 and 1.5mJ. As seen in this plot, the 20-μs and 1-μs energy output did not change appreciably as the voltage input varied. Furthermore, the means of 1-μs energy output for each supply voltage were more similar than those of 20-μs energy output. This suggests that as the time interval used to compute the energy output reduced the corresponding energy outputs were closer to one another despite the change in supply voltage. See Table 1 for the mean and standard deviation of the energy data used to plot Figure 6.

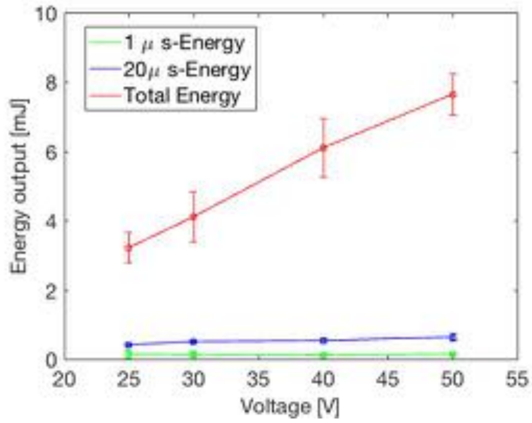


Figure 6: Voltage input vs. calculated total and $1-\mu s$, $20-\mu s$ deposition energy

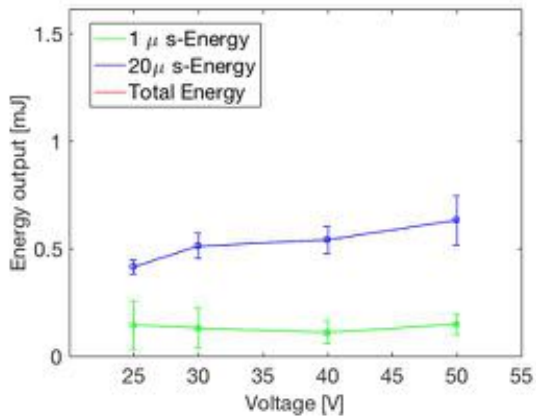


Figure 7: Voltage input vs. calculated $1-\mu s$, $20-\mu s$ deposition energy

	(1)		(2)		(3)	
V	Avg	Std	Avg	Std	Avg	Std
25	0.14	0.11	0.41	0.031	3.22	0.44
30	0.13	0.09	0.51	0.058	4.11	0.72
40	0.11	0.05	0.54	0.062	6.10	0.83
50	0.15	0.05	0.63	0.113	7.65	0.58

Table 1: Voltage input on corresponding mean and standard deviation of energy output. (1): $1-\mu s$ E; (2): $20-\mu s$ E; (3): Total E. All units in mJ

4.2 Propagation of Flame Front

The characteristics of DDT such as the DDT distance and time, l_{DDT} and t_{DDT}, can be studied via the $x-t$ and $x-v$ diagrams. Figure 8 and 9 shows the $x-v$

and $x-t$ diagrams of shot #7 with the voltage input of $25V$. The estimated D_{CJ} based on the experimental data was calculated as the average of all velocities after the point of overdriven detonation (where velocity reached maximum at $\approx 2362m/s$), which was approximately $2191m/s$. The DDT distance is defined as the distance between spark plug and the averaged position between two points during which the propagation velocity of FF becomes greater than 90% of Chapman-Jouguet detonation velocity D_{CJ} for the first time in the $x-v$ diagram. The DDT distance was therefore roughly estimated at $27.45mm$. Similarly, the experimental DDT time was determined using the $x-t$ diagram, in which a clear distinction between the regions of FF and DW was observed. As the flame front approaches the point of detonation initiation, the slope of the curve gradually becomes constant as indicated in Figure 9, suggesting that the flame velocity has reached D_{CJ}. Once the DDT distance was determined from the $x-v$ diagram, the estimated DDT time can be obtained by finding the point along y-axis which corresponds to the position at which DDT occurs along x-axis in the $x-t$ diagram. The estimated DDT time for shot #7 was about $0.32ms$.

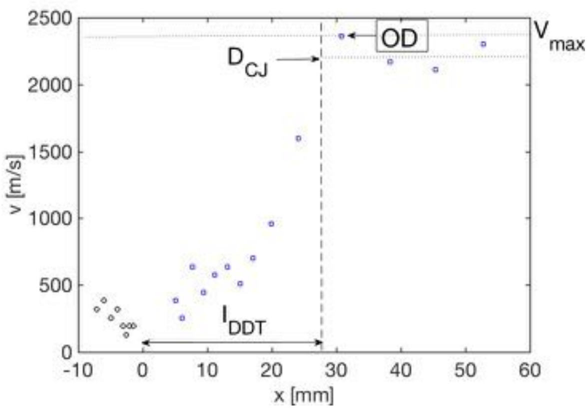


Figure 8: Position of wavefront [mm] vs corresponding flame velocity [m/s]. I_{DDT}: DDT distance; OD: Overdriven detonation; D_{CJ}: Chapman-Jouguet velocity

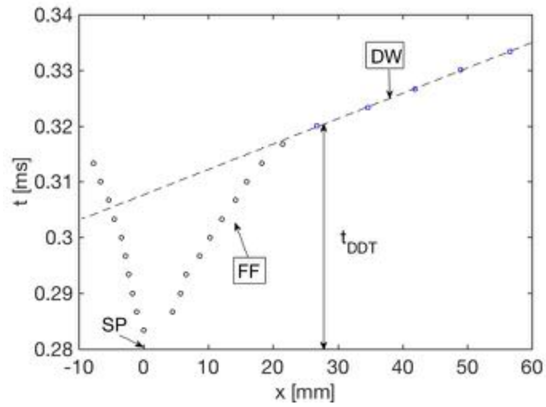


Figure 9: Position of wavefront [mm] in relation to time [ms]. FF: flame front; DW: detonation wave; SP: spark plug position; I_{DDT}: DDT distance

4.3 Visualization of DDT

Figure 10 demonstrates the sequence of schlieren photographs in the time span of about $0.047ms$. In the first frame at $t = 0.280ms$, the boundary layer between fuel mixture and oxidizer above the spark plug was observed. At $t = 0.303ms$, we started to see a clear separation between the shock and flame front. The decoupling became more pronounced later on as captured at $t = 0.310ms$ because the flame front experienced blockage of spark plug as it propagated backward and thus was slowed down relative to the shock front. The separation persisted in the regions where the concentration of oxidizer was higher because the flame speed was reduced more in those regions. The DDT distance could also be estimated from the sequence of schlieren photographs. It was defined as the distance between the position of spark plug to the flame front at the time frame right before the onset of detonation occurred.

To understand the process of DDT, it is important to first know the difference in the ignition mechanisms between a deflagration and a detonation: diffusion (for a deflagration) versus autoignition (for a detonation). So the deflagration-to-detonation transition is essentially the process during which the the switchover from diffusion to autoignition occurs due to shock compression. This suggests that an abrupt explosion, as shown in the time frame of $t = 0.320ms$ in Figure 10, always occurs at the onset of detonation, which is also when the flame has reached a velocity of roughly the CJ deflagation speed. The cause of this sudden explosion could be associated with the adiabatic compression of the reactants caused by the precursor shock [6].

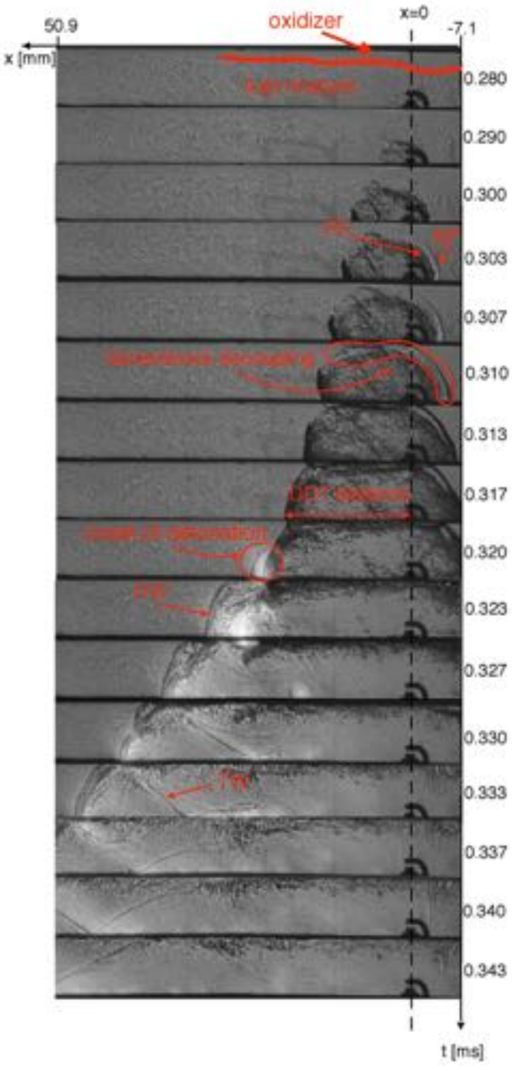


Figure 10: Sequence of schlieren photographs of shot # 7 to estimate DDT distance. FF: flame front; SF: shock front; DW: detonation wave; TW: transverse wave

4.4 Dependency of Total Output Energy on DDT Distance and Time

It was initially expected that the total output energy, as defined earlier in Section 4.1, would directly influence the DDT distance and time. However, our experimental results did not suggest an obvious dependency between the total output energy and the DDT distance and time. The experimental data of output energy and the corresponding DDT distance and time can be found in Table 2 and 3. In the data tables, the DDT distance and time were only estimated from the schlieren films and not derived from the $x-t$ and $x-v$ diagrams. As shown in Figure 11, the mean DDT distances of various total output energy ranging from 3 to 8mJ all lie in the region of 20 - 30mm, with a higher standard deviation for the cases of higher total output energy. Similarly, there was no significant difference found in the resulting DDT times for total output energy varying between 3 to 8mJ. Figure 12 shows the error plot between the total output energy and the DDT time, in which one could see the mean DDT times of various total output energy in the range of 3 to 8mJ were no more than 0.02ms away from one another. As a result, no apparent conclusion could be made about the dependency of total output energy on the enhancement of DDT process.

Shot #	Voltage	I_{DDT} [mm]	t_{DDT}[ms]
2	30	33.19	0.320
3	25	21.28	0.323
4	20	(no ignition)	-
5	40	19.15	0.293
6	25	26.17	0.337
7	25	21.06	0.317
8	50	26.17	0.297
9	50	28.09	0.3
10	30	22.13	0.323
11	30	25.32	0.317
12	40	32.98	0.310
13	40	30.64	0.313
14	50	41.06	0.323

Table 2: DDT time and distance vs. voltage input

Voltage	Shot #	1μs energy [mJ]	20 μs energy [mJ]	Total energy [mJ]
50	8	0.149	0.659	7.10
	9	0.101	0.507	7.59
	14	0.192	0.727	8.25
40	5	0.0522	0.581	6.84
	12	0.122	0.469	5.20
	13	0.154	0.570	6.27
30	2	0.0334	0.548	3.48
	10	0.222	0.539	4.90
	11	0.135	0.444	3.95
25	3	0.0215	0.435	2.87
	6	0.246	0.377	3.09
	7	0.163	0.430	3.71

Table 3: Energy output vs. voltage input

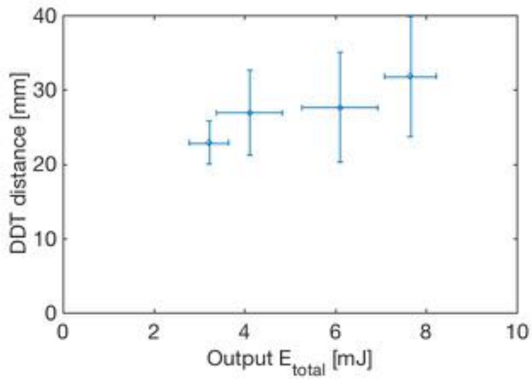


Figure 11: Total Energy vs DDT distance error plot

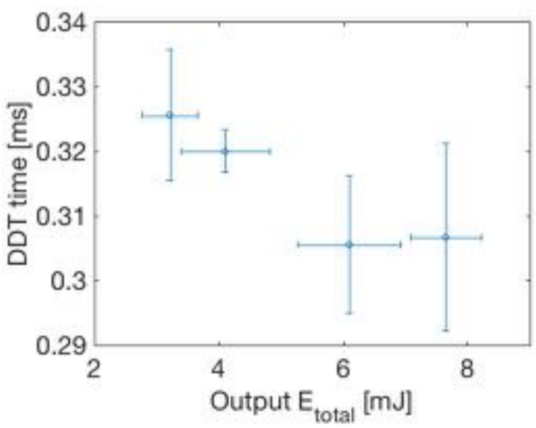


Figure 12: Total Energy vs DDT time error plot

4.5 Chapman-Jouguet Detonation Velocity D_{CJ} and Pressure P_{CJ}

Tho ensure the validity of our experimental data, it is necessary to cross-examine the experimental with theoretical Chapman-Jouguet detonation velocity D_{CJ} and pressure P_{CJ}. The experimental pressure of detonable mixture P_d was derived by averaging the data values measured by PCB1 at $x = 60mm$ over the timespan of $50\mu s$ right before the pressure spikes near to P_{max}. The mean P_d of the 12 shots measured was 0.106 MPa, while the mean temperatures of oxidizer T_o and fuel T_f were about $304.6K$ and $301.9K$. Furthermore, the mean peak pressure of the 12 shots measured by PCB1 was $2.68MPa$, which was defined as the experimental P_{CJ}. The theoretical P_{CJ} was determined via the NASA CEA (Chemical Equilibrium with Applications) online program. By specifying the type of fuel (C_2H_4) and oxidizer (O_2), the pressure ($P_d = 0.106MPa$) and temperature ($T_d = 300K$) of detonable mixture, we found the theoretical P_{CJ} was computed to be $2.69MPa$, which was in very close agreement with our experimental $P_{CJ} = 2.68MPa$.

The theoretical D_{CJ} was derived by summing the filling speed of mixture u_d with the calculated D_{CJ}, which assumes the initial flow condition is static. Since the flow was not initially static in our experiments, u_d must be accounted for in finding the correct theoretical D_{CJ}. A quick way to find u_d is to first determine the ratio of velocity of oxidizer V_o to sonic velocity V_s, which are defined as

$$V_o = \frac{\dot{m}}{\rho A} \tag{8}$$

$$V_s = \sqrt{\gamma R T}, \tag{9}$$

where $\dot{m} = 4.24g/s$ is the mass flow rate of oxidizer, $\gamma = 1.4$ the Poisson constant, $R = 8.31\frac{kgm^2}{s^2Kmol}$ the gas constant, A the cross-sectional area of combustor, and $\rho = P_d/(RT)$ the density. If this ratio is in the neighborhood of unity then the flow of oxidizer is said to be choked and the filling speed of mixture is simply equivalent to the sonic velocity. The results from NASA CEA program showed that the ratio of V_o to V_s was about 0.94, which was close enough to 1 that u_d could be treated as V_s. Therefore, the theoretical Chapman-Jouguet detonation velocity was $D_{CJ} + u_d = 2052.7 + 328.6 = 2381.3(m/s)$ for the conditions $T_d = 300K$ and $P_d = 0.106MPa$. Compared to the experimental $D_{CJ} = 2191.5m/s$, the percentage of error between the experimental and theoretical D_{CJ} was

$$\frac{D_{Exp_{CJ}} - D_{Theo_{CJ}}}{D_{Theo_{CJ}}} = \frac{2191.5 - 2381.3}{2381.3} * 100\% = -7.97\%.$$

The small percentage of error led us to conclude that the experimental Chapman-Jouguet detonation velocity agreed closely with the theoretical one.

5 CONCLUSION

Our experiment suggested that the enhancement of DDT did not directly depend on the total energy output produced by our spark ignition system. However, because the measured DDT distance and time were not significantly different from each other as we changed the supply voltage and transient energy output at the instant of spark initiation were similar for all cases, it is possible that the instantaneous energy deposition at the time of spark initiation is a more important parameter to consider for the enhancement of DDT. Future work to improve our current experiment includes the investigation of using laser ignition as a spark mechanism to enhance the DDT process. A laser ignition system is able to deliver quick and high-density energy in a short period of time to the spark plug. By varying the intensity of laser source, we can adjust the instantaneous energy deposition at the time of spark initiation accordingly. Therefore, the enhancement of DDT can be realized as the energy deposition at the moment of spark increases.

ACKNOWLEDGEMENT

This work was supported by the Propulsion and Energy Systems Engineering Group led by Professor Jiro Kasahara of Nagoya University. In particular, I would like to extend my sincere thanks to Professor Ken Matsuoka for his constant supervision and guidance on this project as well as all the lab members who participated in it.

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VISION BASED PATH FOLLOWING VIA RANDOMIZED MODEL PREDICTIVE CONTROL

Muzhi Zhu

Department of Mechanical Engineering, Graduate School of University of Michigan

zhumuzhi@umich.edu

Supervisor: Prof. Tatsuya Suzuki

Graduate School of Engineering, Nagoya University
t_suzuki@nuem.nagoya-u.ac.jp

ABSTRACT

This report demonstrates a randomized model predictive control (RMPC) design to perform autonomous path following via camera. The desired path is generated via camera capture of red tape on the ground, the skewed view image capture is transformed into bird view. The reference path is assumed to follow parabolic shape. Kinematic bicycle model is utilized to construct RMPC controller to generate predicted path, the series of optimized steering angle is generated via uniformly distributed sampling and evaluated by the objective function. Constant velocity command is issued for the sake of this work. The designed controller is examined upon ZMP RoboCar 1/10 2016, which is a front wheel steering, rear wheel driving robot car. The experimental results show the effeteness of the proposed approach.

1. INTRODUCTION

Autonomous driving has been a major focus for automotive research. For it has the potential to improve safety, transportation efficiency, productivity, accessibility, and more environmentally friendly [1].

The major components for autonomous driving or advanced driving assistant system (ADAS) are localization, perception, and control. This work focus on the perception and control parts. The perception of the environment is conducted by a single camera mounted on the vehicle body. Red tape on the ground is identified as reference path for the vehicle to follow; the steering control to follow the reference path uses RMPC, which is a control method that predicts future behaviours of the controlled object based on observation and models at every time step, randomly generates control inputs, and decides the optimal input series under a predetermined objective function. Then first input of the optimal series is selected to feed in the plant.

The perception of the path and the RMPC strategy are examined by ZMP RoboCar 1/10 2016 shown in Fig.1, which is a front wheel steering, rear wheel driving robot car.

Fig. 1 ZMP RoboCar 1/10 2016

This report contains 4 sections. Section 1 is the introduction; section 2 describes the system modelling and controller construction; section 3 discusses the experimental setup and results; section 4 concludes the work and suggests potential improvement that can refine the performance.

2. SYSTEM MODELING

The system modeling is consisted of 3 subsystems: path approximation; kinematic bicycle model; and RMPC construction.

2.1 Path Approximation

The reference path is captured by the camera which is mounted on the vehicle body shown as in Fig 2. (Ref[2])

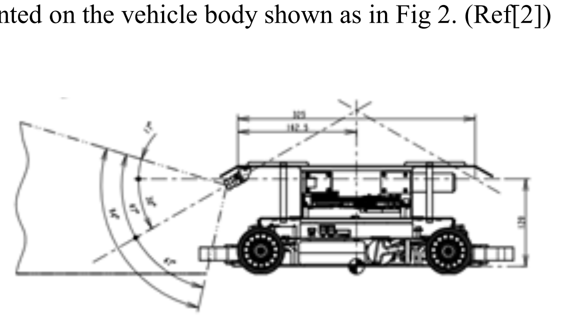

Fig. 2 Skewed Mounted Camera

The unmodified image capture shows follows:

Fig. 3 Original Image Capture

However, for the sake of this work, the vehicle is assumed to drive at the same horizontal plane, thus it is more convenient to acquire the information of the path in bird view. OpenCV embedded function *getPerspectiveTransform* and *warpPerspective* are used to conduct the transformation. The results shows as Fig.4.

Fig. 4 Bird View of the Path

After acquiring the bird view image, the camera acts as if it capture images from the top rather than a skewed down vision point. In order to detect the red path, transfer the BGR image into HSV image and detect the red path using OpenCV embedded function *cvtColor* to convert the color coordinate*, GaussianBlur* to smooth the image and *Canny* to detect the edges of the path. The edge detection results and the parabolic fitting shows in Fig.5.

Fig. 5 Canny Edge Detection and Curve Fitting of Red Path

As can be seen from the results, the parabolic fitting matches the path well. However, it should be noted that color detection would be effected by the light condition and reflection, which could influence the identification of the reference path.

The last step for the perception portion of this work is to perform camera calibration form image pixel frame to vehicle body frame. The original of the coordinate system build at the center of the mass for the vehicle, forward direction as +Y direction, counter clockwise 90 degree as +X direction. After selecting 4 points on shown in the captured image and measure the coordinate with respect to the center of mass, the transformation from image pixel frame to vehicle body frame can be expressed as:

$$x = -1.445\,px + 239.833 \quad (1)$$

$$y = 1.445\,py + 564 \quad (2)$$

Where x,y are the coordinate in vehicle frame, px, py are pixel coordinate in image frame.

2.2 Kinematic Bicycle Model

Kinematic bicycle model [Ref.3] is utilized to describe the states of the vehicle. The model is derived from the kinematic relationship of motion. The velocity and steering angle dynamics are not considered.

The kinematic bicycle model shows as Fig.6

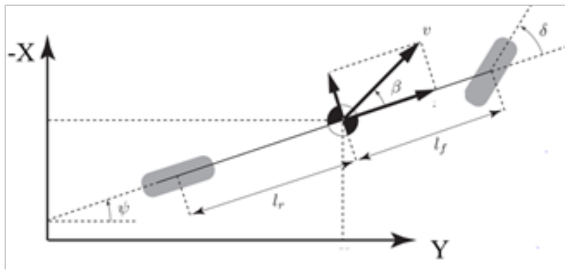

Fig. 6 Kinematic Bicycle Model

The nonlinear continuous states equations can be described as follows

$$\dot{x} = v\sin(\psi + \beta) \quad (3)$$

$$\dot{y} = v\cos(\psi + \beta) \quad (4)$$

$$\dot{\psi} = \frac{v}{l_r}\sin(\beta) \quad (5)$$

$$\beta = \tan^{-1}\left(\frac{l_r}{l_r + l_f}\tan(\delta)\right) \quad (6)$$

where for each frame capture, assume the vehicle forward direction as +Y direction, counter clockwise 90 degree as +X direction; v is the velocity for the center of mass; (x, y) is the center of the vehicle body coordinate in car frame; ψ is the vehicle heading angle; β is the angle between the vehicle center of mass velocity and the longitude direction at each prediction time step; δ is the front wheel steering angle; l_r and l_f are the length between the center of the mass to the rear wheel axis and front wheel axis respect.

The kinematic model above assumes no tire slip and no steering angle dynamics. Constant velocity is issued for this study as an initialization parameter, its dynamics is captured by the steering angle and encoder measurements. The kinematic bicycle model is easy to implement as the only parameters need to be identified are l_r and l_f, which are both 128mm for ZMP RoboCar 1/10 2016.

2.3 RMPC Construction

To implement the continuous nonlinear vehicle model described in section 2.2 on the embedded system platform. The system is discretized, and instead of the using the desired velocity directly, the velocity for the center of mass is estimated based on the measurement for 4 wheels encoders and the steering angle shows in Eq.7, where v_r and v_f are the average of the rear and front encoders reading; δ is the measured steering angle.

$$v = \sqrt{\left(\frac{v_r}{2} + \frac{v_f}{2}\cos(\delta)\right)^2 + \left(\frac{v_f}{2}\sin(\delta)\right)^2} \tag{7}$$

The discretized model used for prediction shows as follows:

$$x_{k+1} = x_k + \Delta t \cdot v\sin(\psi_k + \beta_k) \tag{8}$$

$$y_{k+1} = y_k + \Delta t \cdot v\cos(\psi_k + \beta_k) \tag{9}$$

$$\psi_{k+1} = \psi_k + \Delta t \cdot \frac{v}{l_r}\sin(\beta_k) \tag{10}$$

$$\delta_{k+1} = \delta_k + \Delta\delta \tag{11}$$

$$\delta_{k+1} = \frac{\tau}{\Delta t + \tau}\delta_k + \frac{\Delta t}{\Delta t + \tau}\delta_{k+1} \tag{12}$$

Where the steering difference of the between each time step is sampled through a uniform distribution generator. Eq.12 serves as a low pass filter to smooth the generated new input.

The constraint caused by the physical limitation of the vehicle, which is:

$$-30° \le \delta_k \le 30° \tag{13}$$

The objective function to be minimized is constructed as:

$$J = \sum_{k=1}^{N} w_k \left[\varphi_k{}^T Q \varphi_k + (\delta_k - \delta_{k-1})^T \overline{R} (\delta_k - \delta_{k-1})\right] + \delta_N{}^T R \delta_N \tag{14}$$

where N is the predicted time horizontal length; $\varphi(k|t)=[x_k - x_{ref}]|(y_k = y_{ref})$ is the distance between the predicted vehicle's front end and the corresponded reference path at each time step; δ_k stands for the steering angle at each predicted time step; $Q, R, \overline{R}, w_k$ are weight parameters to be tuned. The magnitude of final steering angle is not a concern for this study, thus R is always set to be 0. The error term is used to minimize the distance error, and the input difference term is used to smooth the input.

At each execution step, the program would generate Ns series of inputs with predicated horizontal length N. Evaluate the Ns series by the objective function to find the series with lowest value, then issue the first generated input to the vehicle steering actuator as the output of controller.

RMPC is easy to implement for it bypass the nonlinear MPC optimization problem by generating large set of samples and selected the best set by the criterial of objective function. However, it should be noted that the generation of large set of samples would consume computation power and slower the execution process.

3. RESULUTS AND DISCUSSION

To demonstrate the effeteness of the controller design, experiments for the vehicle to track the red tape on the ground.

3.1 Experimental Setup

As described in the previous section, in order to implement the design in embedded system, the bicycle model is discretized and time step is defined as:

$$\Delta t = \frac{10mm}{v} \tag{15}$$

Where v stands for the vehicle velocity command issued to the vehicle. Varying the time step used for model perdition as such ensures the model to generate a location prediction at every 10mm. Because the image shown in the bird view can roughly display a 300mm further away from the vehicle. Thus the predicated horizontal length N is selected as 30. As a result, at each RMPC loop, the system would evaluated 300mm away from its front.

The steering difference of the steering angle is sampled via a uniformly distribution between -15°and 15°.

3.2 EXPERIMENTAL RESULT

Experiments are performed under different set of parameters combinations and velocity initiation.

The summarized parameters shows as in Table.1.

Table 1 Parameter Summarized

v [mm/s]	Ns	N	Q	R
100	1500	30	1	0

The first set of experiments running examine the effect of change the weight w_k in Eq.14 under 100mm/s.

The experiments results with 4 different of weight that emphasize on the position error uniformly, weight more on the near end, far end, and midway of the prediction are performed. Results are shown in Table.2 and Fig.7 to Fig.9.

Table 2 Average Error for Different Weight under 100mm/s

Weight	1	N-k	N^2-$(0.5N\text{-}k)^2$	k
Average Error [mm]	21.80	31.62	32.30	20.95

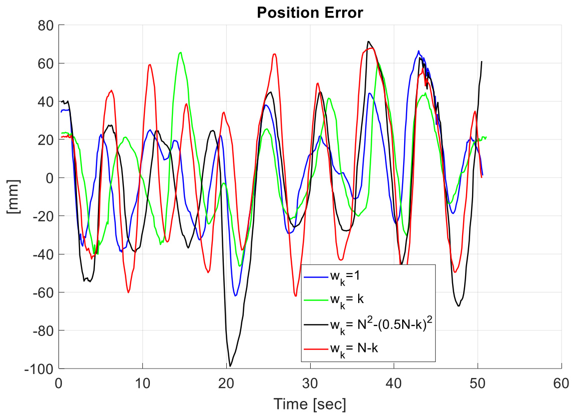

Fig. 7Error Dynamics for Different Weight under 100mm/s

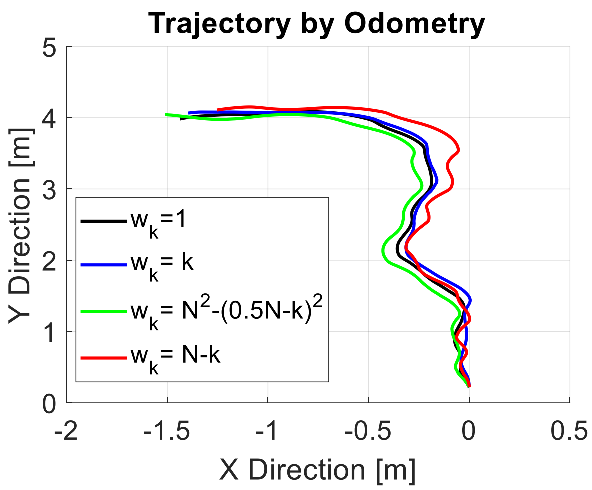

Fig. 8 Odometry for Different Weight under 100mm/s

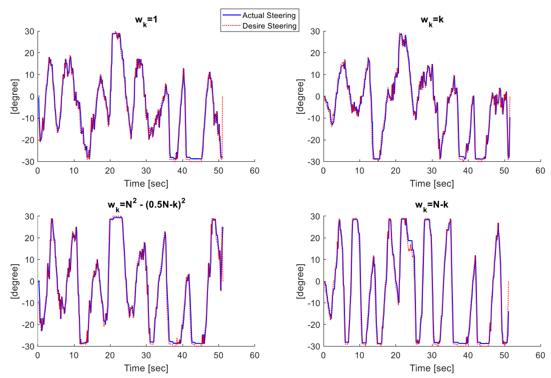

Fig. 9 Steering for Different Weight under 100mm/s

As can be seen from the results, the position error are in general small, but put more weight on the far end and uniformly leads to the best performance. Besides, the steering is oscillating, further smooth mechanism need to be implemented.

The effects of the weight parameter $\bar{R}$, which aims to smooth the steering command, is also tested. The experimental results shows as follows:

Table 3 Average Error for Different Input Weight $\bar{R}$

$\bar{R}$	0	5	10	15
Average Error [mm]	41.71	37.77	46.25	39.88

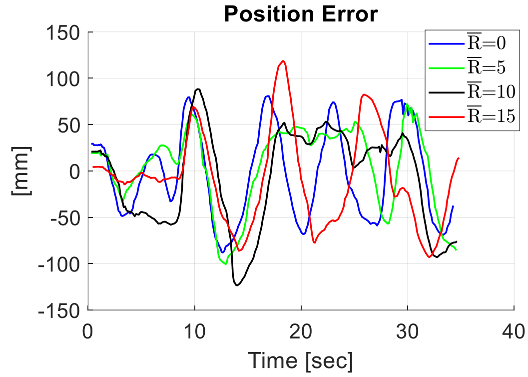

Fig. 10 Error Dynamics for Different Weight $\bar{R}$

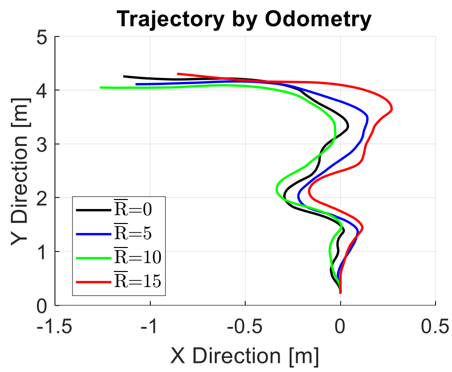

Fig. 11 Odometry for Different Input Weight $\bar{R}$

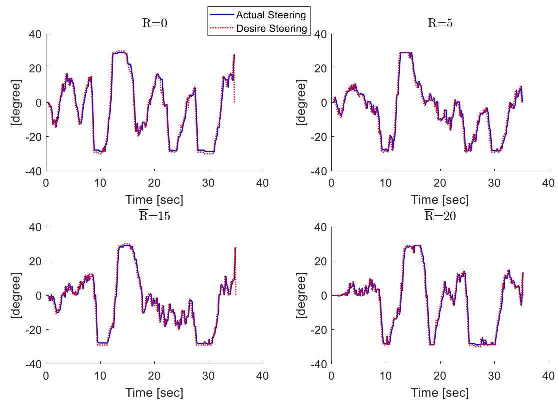

Fig. 12 Steering Angle for Different Input Weight $\bar{R}$

As can be seen from the results, the trajectory is pretty consistent and the input weight parameter has the effect to smooth the steering angle command.

It should be noted that in the actual experimental result, the smallest average error comes from the $\bar{R}$=5 rather than $\bar{R}$=0. It could be caused by the stochastic nature of the sampling, or the smoothing cancelled the time delay effect of the vehicle.

To examine whether the smoothness factor is effective. The difference of the actual steering angle and its spectrum are shown as follows.

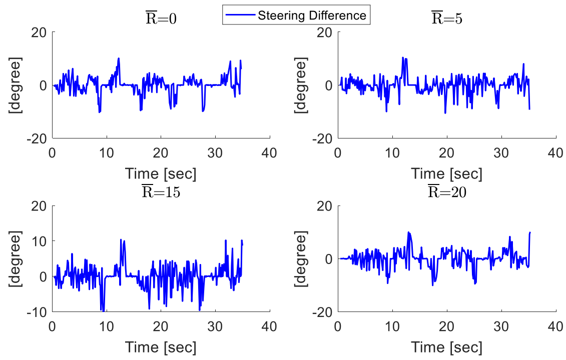

Fig. 13 Steering Angle Difference for Different $\overline{R}$

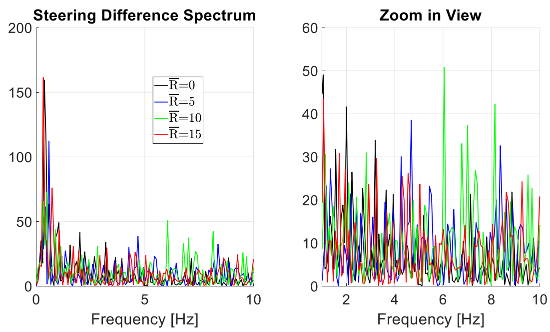

Fig. 14 Spectrum for Steering Angle Difference for Different $\overline{R}$

The frequency peak below 1 frequency caused by road condition change, thus is not the concern for the smoothness parameter. From the zoom in view, it is unexpected to view that $\overline{R}$ =10 has the largest high frequency component. Thus to further examined the effect of the weight factor, more control variable experiments need to be performed.

Effect of different velocity is also tested. The results shows as in Table. 4 and Fig.:

Table 3 Average Error for Different Weight

Set Velocity [mm/s]	50	100	150	200
Average Error [mm]	16.61	20.95	41.87	90.79

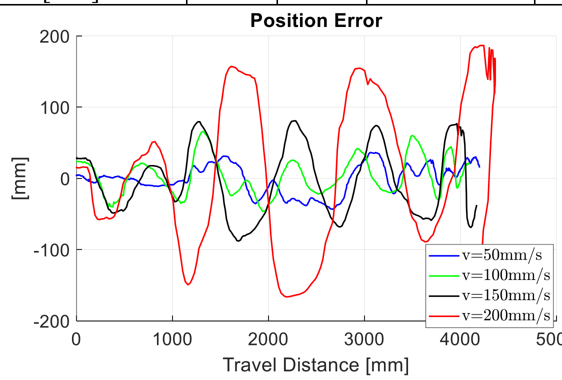

Fig. 15 Error for Different Velocity

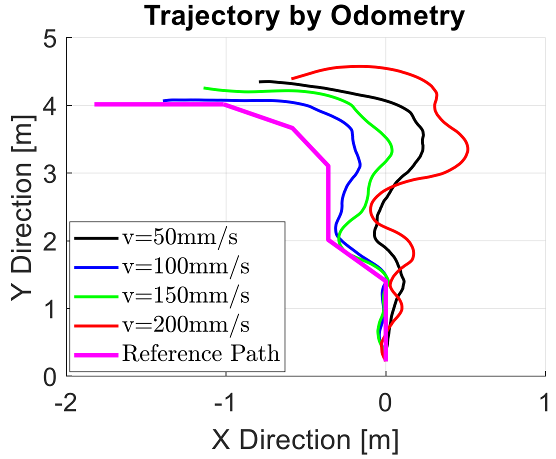

Fig. 16 Odometry for Different Velocity

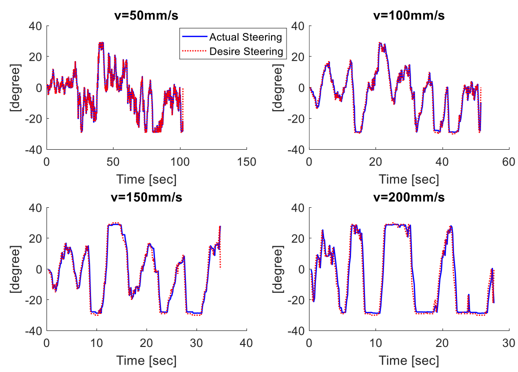

Fig. 17 Steering for Different Velocity

As can be seen from the results, the larger the velocity, the larger the position error, which is expected. The lower velocity error cases has more steering oscillation and generate a better path following performance. It should also be noted that the odometry solely relay on encoders is not reliable. The tire slip angle is ignored in the model, which would affect the actual velocity direction of the vehicle. As for all the tested results demonstrated at this section, the vehicle achieve the same final destination, however, from odometry it is clear that these trial stop at different location. The main reason caused the issue could be the untruthful yaw estimation based only on odometry, as the comparison to the reference path shows that the vehicle did bit turn enough angle. Thus to truly reelect the word position of the vehicle, additional sensors are desired.

4. CONCLUSTION AND FUTURE WORK

The report developed a RMPC design to perform red path following using camera captured image. The controller design is validated through experiment. The results demonstrate functionality of the control design, better performance can be achieved by parameters tuning to realize a good trade-off between effective sampling and smaller computation time.

For future work, there are several potential approach to refine the control design. Primarily, instead of RMPC that solve for the solution through randomly sampling, variety of stochastic and deterministic optimization methods to solve for a numerical solution for the nonlinear MPC problem with less computation time, which is a large concern under RMPC. Beside, more sophisticated vehicle model such are dynamic vehicle model can be implemented with additional parameters identification for the force analysis. Moreover, velocity control can be implemented based of the reference path as well. More sensors such as IMU and Lidar can be utilized to perform localization for the vehicle in word frame, as can be seen from the testing results that the localization solely rely on encoders can only reflect the vehicle position roughly.

ACKNOWLEDGEMENTS

I would gratefully thanks Prof. Suzuki for giving me the opportunity to join his laboratory and conduct this study in the summer. I would like to thanks Prof. Okuda and Prof. Shimizu for their guidance through the project. A special thanks to all the lab mates in Suziki Lab, for the memorable summer we share together.

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HUMAN PRESENCE SENSING OF A MOBILE ROBOT BY USING 2D LASER SCANNER

Chenfan Lian

Department of Mechanical Engineering, Graduate School of Engineering, University of Michigan
cflian@umich.edu

Supervisor: Prof. Yoji Yamada

Graduate School of Engineering, Nagoya University
yamada-yoji@nuem.nagoya-u.ac.jp

ABSTRACT

This paper presents a human presence sensing method of a mobile robot. This method is based on visualizing sensor information from one 2D laser scanner through Robot Operating System (ROS). The sensing algorithm is designed only for the simple open area without disturbance of other obstacles. A series of experiments are conducted to test the algorithm. Finally, an optimized solution of human presence sensing is proposed.

Keywords: human presence sensing, mobile robot, ROS

Undisclosed

The Change of Gait Motion During Curvilinear Obstacle Avoidance while Restricted by a Wearable Robotic Device

Erik Kramer
Department of Mechanical and Aerospace Engineering, University of California Los Angeles
ehkramer@ucla.edu

Yoji Yamada
Graduate School of Engineering, Nagoya University
yamada-yoji@mech.nagoya-u.ac.jp

Yasuhiro Akiyama
Graduate School of Engineering, Nagoya University
akiyama-yasuhiro@mech.nagoya-u.ac.jp

***Abstract*—Lower limb wearable robotic devices designed to aid humans in motion tend to have reduced degrees of freedom (DoF) when compared to human legs. These limit the wearer movement and as a result significantly alter common gait types. One motion that is very integral to everyday life is obstacle avoidance in the form of a curvilinear path. To evaluate the effects a physical assistant robot (PAR) has on such a motion, we conducted a study to compare the gait dynamics of a test subject with and without the PAR restricting their hip movement out of the sagittal plane as they moved around a "S" shaped path. Results showed that hip rotation is the dominant factor which alters natural gait motion with the PAR's restrictions engaged. Center of mass (CoM) trajectories showed that due to rotation restrictions a stable repeatable path was more difficult to obtain when restricted by the device, especially around smaller radii curves. Hip rotation is thus deemed critical to fluid turning and movement of this DoF should be an important factor when designing PAR devices that are used to make curvilinear motions.**

Undisclosed

CONVERSE PIEZOELECTRIC EFFECT INDUCED SEPARATION OF THICK GAN FILM FROM THE SIC SUBSTRATE

Jia Wang

(Affiliation) Department of Materials Science, Graduate School of Engineering, UCLA
wangjia@ucla.edu

Supervisor: Hiroshi Amano

(Affiliation) Graduate School of Engineering, Nagoya University
amano@nuee.nagoya-u.ac.jp

ABSTRACT

A novel method which strategically makes use of converse-piezoelectricity of wurtzite single-crystal of AlN and GaN as driving source has been designed to separate the GaN thick film from the substrate. The energy generated from the converse-piezoelectric effect of AlN buffer layer can be engineered to compensate the hetero-epitaxial interface energy between AlN and GaN, which is further assisted micro-voids formed above the tungsten mask serving as crack nucleation site during the epitaxial lateral overgrowth of GaN. AlN plays the dual role of buffer/nucleation layer and piezoelectrically polarized layer. Tungsten is used as masks to filter the growth of GaN as well as electrodes to polarize AlN. In this way, thick GaN film can be released from the well-prepared substrate as freestanding GaN even at high temperature as AlN features ultrahigh Curie temperature. Such method shows strong promise to produce ultra-large GaN wafers with high-yield and low-cost.

Undisclosed

STABILITY OF PREFORM SHAPE DURING REACTIVE SYNTHESIS OF AL-TIC COMPOSITES

Zhiwei Liu

Department of Materials Science and Engineering, University of California Los Angeles
zhiweimse@ucla.edu

Supervisor: Prof. Makoto Kobashi

Department of Materials Processing Engineering
Graduate School of Engineering, Nagoya University
kobashi.makoto@material.nagoya-u.ac.jp

ABSTRACT

A new process, reactive combustion synthesis, was investigated to synthesize Al-TiC composites. Different volume percent of titanium and carbon powder are replaced by directly incorporated TiC particle and the influence of the TiC particle replacement on the temperature peak during combustion reaction, volume change(porosity) and final preform shape was systematically investigated. With the increase of the TiC particle replacement, the temperature peak during combustion reaction tends to decrease gradually. Also, the optimal volume percent of TiC particle replacement was investigated around 10%.

1. INTRODUCTION

Light metal matrix composites have undergone fast development due to their high specific strength, low density, high wear resistance, high-temperature strength and good thermal stability [1]. Their promising properties lead to great potential in applications ranging from commercial automobile industries to aerospace engineering [2]. For the fabrication of light metal matrix composites, various conventional techniques such as mechanical alloying, powder metallurgy have been used to achieve that. However, since the reinforcement was directly incorporated to the molten state of the metal matrix, the potential interfacial reaction between the metal matrix and reinforcement leads to the poor wettability and decreased bonding strength between the reinforcement and metal matrix [3]. Recently, combustion reaction, a kind of in-situ processes to fabricate metal matrix composites, have aroused grand interests among researchers. Combustion reaction synthesis, also known as self-propagating high temperature synthesis(SHS), is the process that uses the heat released by chemical reaction to synthesize intermetallic and ceramics in very short time [4]. Since the temperature of the reaction is very high and the solid metal matrix can be melted to liquid state, so the reinforcement can potentially be homogeneously dispersed into the metal matrix. This fabrication method has a lot of appealing advantages such as clean interface and perfect bonding between metal matrix and reinforcement, uniformly dispersed reinforcement leading to the improvement of the mechanical properties. However, it is known that many pores are formed in the specimen after reaction when TiC volume fraction is high. One reason for this high porosity is strong heat of reaction ($Ti + C \rightarrow TiC + Q$), which leads to the evaporation of aluminum. Another reason is that gas element (mainly hydrogen) dissolved in elemental powders is released when TiC is formed.

Great attention has been focused on the aluminum matrix composites nowadays because of their attractive properties such as specific strength, stiffness, low density and wear resistance. Also, TiC is the ideal reinforcement for the aluminum matrix composites due to its high hardness and high temperature thermal stability.

In this paper, aluminum matrix composite reinforced with TiC particle was synthesized via combustion reaction process from the compact mixture of aluminum powder, titanium powder and carbon powder. Also, since the combustion reaction of the Al, Ti and C system will lead to high volume percent of porosity in the final product which is not beneficial for structural application, different volume percent of TiC particle will be directly incorporated to replace corresponding amount of titanium and carbon powder to reduce the porosity thus the original shape of the final product can be maintained.

2. EXPERIMENTAL

Titanium powder (particle size<45μm, purity 99.9%), aluminium powder (particle size<45μm, purity 99.9%), carbon powder (mean particle size of 5μm, purity 99.7%) and TiC particles (particle size 2~5μm, purity 99%) were used as starting materials. The mole blending ratio of carbon powder, aluminum powder and titanium powder is 1:1:1, so the calculated volume percent of TiC in the final product is estimated to be 55%. For the replacement of the carbon powder and titanium powder with TiC particle, 10vol.%, 15vol.% and 20vol.% of TiC particle replacement were designed to evaluate the influence of TiC particle replacement on the temperature peaks and volume change of the final product in the experiment.

Aluminum powder, titanium powder, carbon powder and titanium carbide particle for different scenarios are weighed and then fully mixed in the quartz crucible for 15min. Then the mixture of powder blend was compacted into a cylinder shape with the diameter of 9.5mm under the pressure of 100MPa. Finally, the compacted powder blends were heated in the induction furnace to induce combustion reaction under the protection of argon gas. The schematic experimental setup for the induction heating is shown in Fig.1. The thermocouple was put on the surface of the powder compact to monitor the temperature during the combustion reaction. When the temperature peak appears, the heating was stopped immediately and cooled in the furnace subsequently.

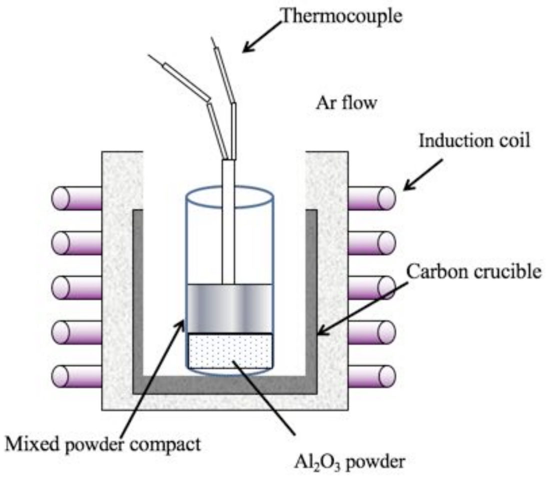


Fig.1 Schematic illustration of induction heating

After combustion reaction, samples of Al-TiC composites were cut into two pieces, one of which was inserted into resin and then prepared by grinding, and the cross section of the samples was observed using optical microscope(OM) and scanning electron microscope(SEM).

3. RESULT AND DISCUSSION

3.1 Reaction mechanism of the combustion synthesis

The reaction mechanism of the fabrication of Al-TiC composites by combustion synthesis is schematically shown in the Fig.2.

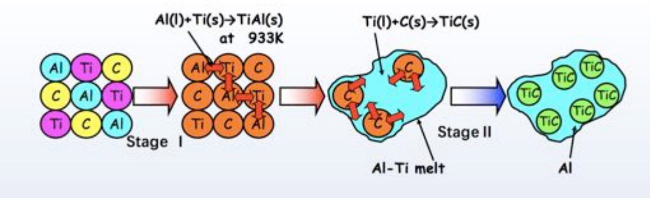


Fig.2 Schematic illustration of the combustion reactions for Al-Ti-C system

During the induction heating, when the temperature was raised to the melting point of aluminum (973K), the reaction between aluminum and titanium would occur first, and the layered structure of Al-Ti would be formed. When the temperature is high enough, reaching the melting point of Al-Ti intermetallic(1733K), the Al-Ti intermetallic would be melted and the reaction between the Ti powder and carbon powder would occur fast since it is the solid-liquid reaction. The reactions that occurred during the combustion synthesis are shown in the Fig.3. and the reactions mentioned above are the heat releasing reactions.

$$Al_{(s)}+Ti_{(s)} \rightarrow AlTi_{(s)} \quad \Delta H = -86.1KJ/mol$$

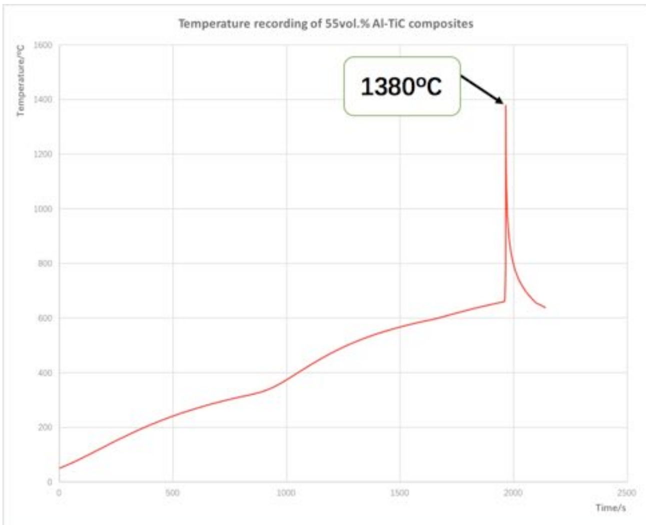
$$Ti_{(s)}+C_{(s)} \rightarrow TiC_{(s)} \quad \Delta H = -184.5KJ/mol$$

Fig3. Reactions that occurred during combustion synthesis

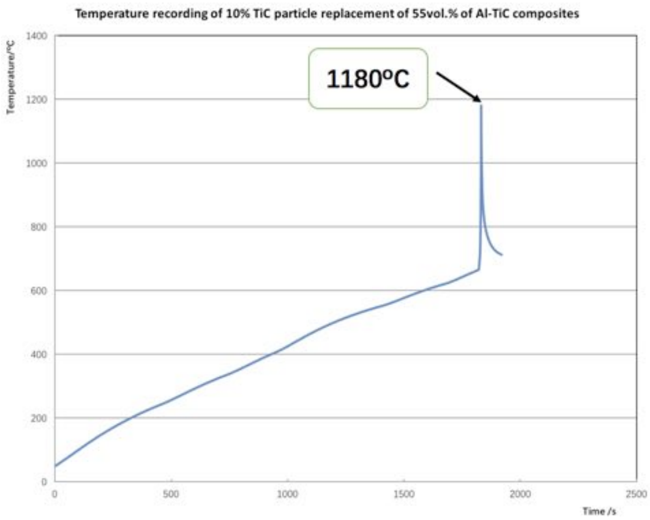
3.2 Temperature peaks during the combustion reaction

In the experiment, when the temperature was raised to the melting point of aluminum(973K), the reaction between aluminum powder and titanium powder occurred with certain amount of heat release, in the meantime the AlTi intermetallic was formed. If the temperature could reach up to the decomposition temperature of AlTi, the reaction between titanium powder and carbon powder would occur subsequently with even higher amount of heat release. Therefore, we could see the temperature peaks in the temperature monitor. However, the higher heat release would lead to the higher percentage of porosity in the final product which we would talk about later. Therefore, in order to reduce the porosity in the final product, we replace part of the carbon and titanium powder with TiC particle to see their influence on the temperature peaks and porosity.

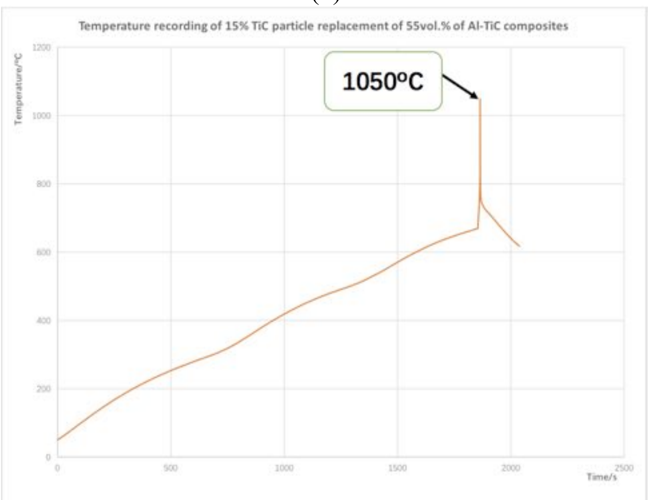
Fig.4(a), 4(b),4(c), 4(d) shows the temperature peaks of the 55vol.% Al-TiC composites with no TiC particle replacement, 10vol.%, 15vol.% and 20vol.% TiC particle replacement respectively.



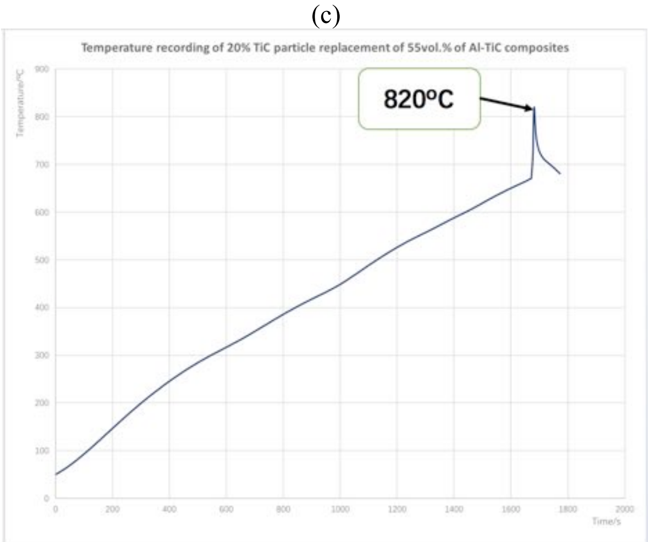
(a)



(b)



(c)



(d)

Fig.4 (a), (b), (c), (d) refer to the temperature peaks of 55vol.% Al-TiC composites with no TiC particle replacement, 10vol.%, 15vol.% and 20vol.% TiC particle replacement respectively.

Since the thermocouple was put on the surface of the powder compact, so the measured temperature peak above is lower than the real temperature peak of the combustion reaction, however, the trend should be the same. From Fig.4, with the increase of the TiC particle replacement, the measured temperature peak decreased gradually and the trend is shown in Fig.5.

The possible explanation for the trend lies in the following two aspects. With the increase of the TiC particle replacement, on the one hand, the reaction between aluminum and titanium powder or carbon and titanium powder decreases, so the heat release decreases. On the other hand, the directly incorporated TiC particle absorbs the heat which leads to the decrease of the temperature peaks.

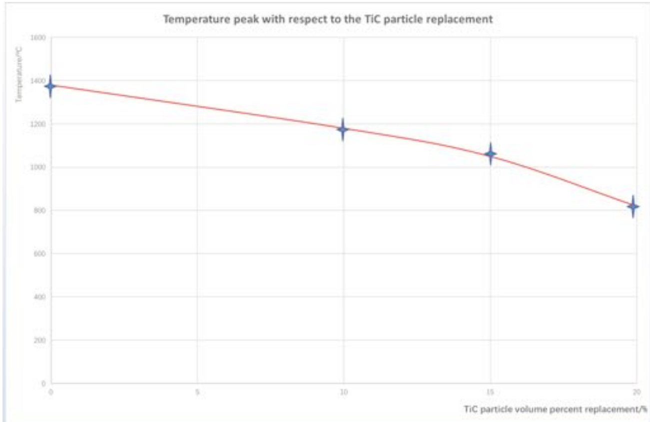


Fig.5 Measured temperature peak with respect to the TiC particle replacement

3.3 Scanning Electron Microscope characterization

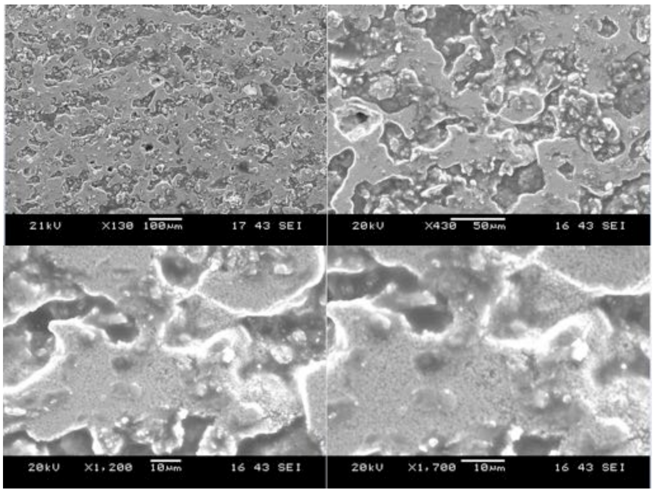
Fig.6(a), (b), (c), (d) show the cross sections of the the 55vol.% Al-TiC composite samples with no TiC particle replacement, 10vol.%, 15vol.% and 20vol.% TiC particle replacement respectively.

Fig.6(a) clearly shows the sample with no TiC replacement is very porous and the synthesized TiC particle from the reaction between titanium powder and carbon powder is seen in high magnification SEM images.

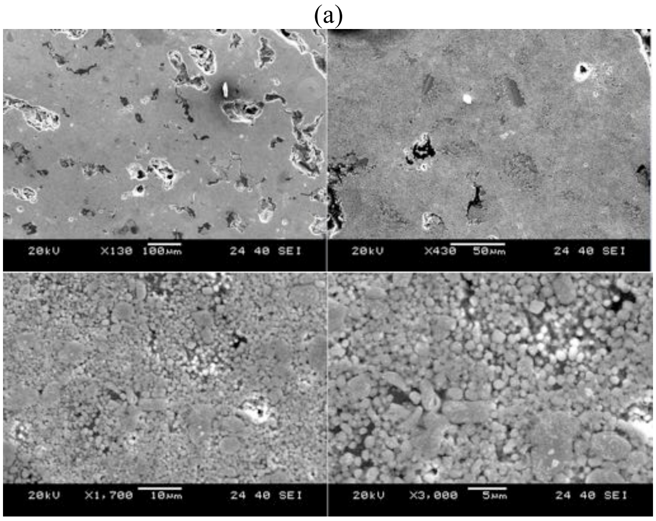
For the samples with 10vol.% TiC particle replacement in Fig.6(b), the volume percent of porosity is apparently lower than the former one which would be demonstrated in the later section. Also, high magnification SEM images clearly shows that the synthesized TiC(smaller spherical ones) and incorporated TiC particle(larger ones) coexisted in the final product.

In Fig.6(c) shows the cross section of the sample with 15vol.% TiC replacement. This scenario is more like the transition from the first stage to the second stage shown in Fig.2 where we have the synthesized TiC particle and the undecomposed AlTi intermetallic.

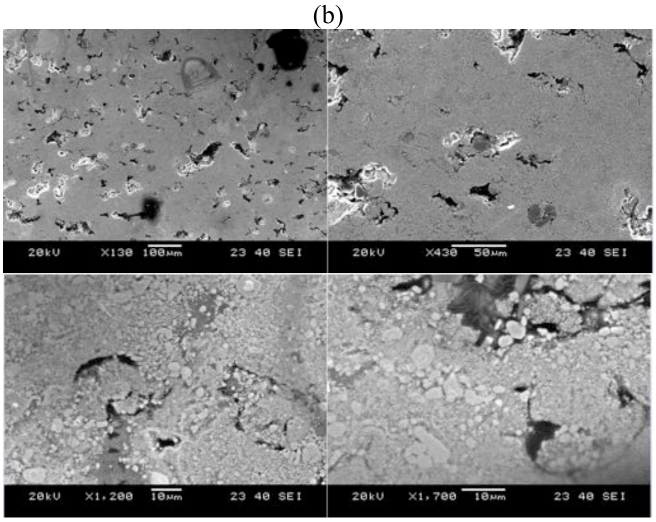
In Fig.6(d), since the TiC particle replacement is relatively high so the temperature peak is too low to melt the AlTi intermetallic. Therefore, no TiC particle is formed from the reaction between titanium powder and carbon powder. The large grain in the SEM image is Ti and the periphery of large Ti grains are assumed to be AlTi intermetallic.



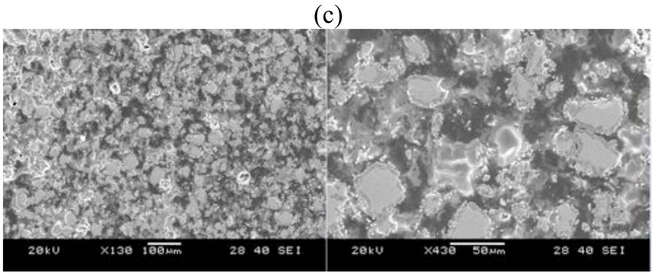
(a)

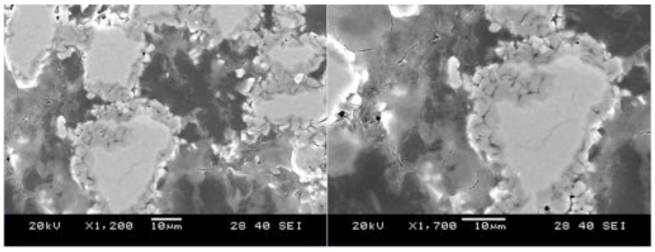


(b)



(c)





(d)

Fig.6(a), (b), (c), (d) are the SEM images of the intersection of 55vol.% Al-TiC composite samples with no TiC particle replacement, 10vol.%, 15vol.% and 20vol.% TiC particle replacement respectively.

3.4 Volume change during the combustion reaction

Since the porosity is difficult to measure in the final product, the alternative way used to evaluate the porosity is to measure the volume change after the combustion reaction, generally higher volume change corresponds to higher volume percent of porosity. Fig.7 shows the images of those Al-TiC composites before and after sintering.

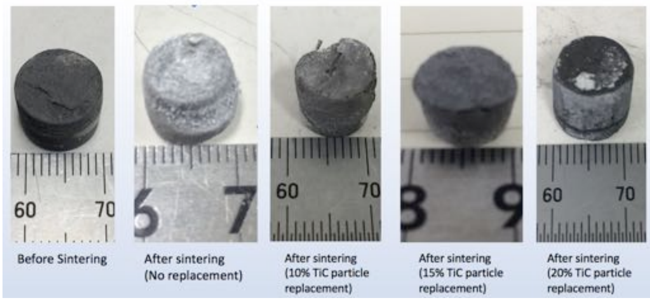


Fig.7 Images of 55vol.% Al-TiC composite samples with no TiC particle replacement, 10vol.%, 15vol.% and 20vol.% TiC particle replacement before and after sintering

Table1(a), (b), (c), (d) shows the height, diameter and volume of the 55vol.% Al-TiC composite samples with no TiC particle replacement, 10vol.%, 15vol.% and 20vol.% TiC particle replacement before sintering and after sintering respectively.

Table 1

Parameters of 55vol.% Al-TiC composite samples with no TiC particle replacement, 10vol.%, 15vol.% and 20vol.% TiC particle replacement before and after sintering

55vol.% Al-TiC (No replacement)	Height(mm)	Diameter(mm)	Volume(mm^3)
Before sintering	7.30	9.65	533.64
After sintering	8.43	10.55	736.54

(a)

55vol.% Al-TiC (10% TiC particle replacement)	Height(mm)	Diameter(mm)	Volume(mm^3)
Before sintering	7.30	9.65	533.64
After sintering	8.17	9.92	631.12

(b)

55vol.% Al-TiC (15% TiC particle replacement)	Height(mm)	Diameter(mm)	Volume(mm^3)
Before sintering	7.65	9.65	559.22
After sintering	8.55	10.33	716.20

(c)

55vol.% Al-TiC (20% TiC particle replacement)	Height(mm)	Diameter(mm)	Volume(mm^3)
Before sintering	7.35	9.65	537.29
After sintering	9.73	11.04	930.93

(d)

The calculated volume change for each TiC replacement scenario before and after sintering are respectively 38.02%, 18.27%, 28.07% and 73% and the trend is shown in Fig.8.

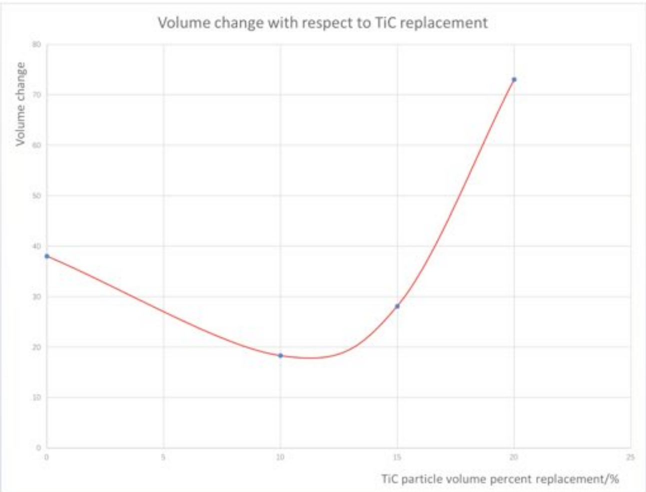


Fig.8 Volume change with respect to TiC particle replacement

Fig.8 shows the volume change with respect to the TiC particle replacement. With the increase of the TiC particle replacement, volume change first decreases and then increases. SEM images in Fig.6 shows that synthesized TiC particle by combustion reaction occurred in both the no TiC replacement and 10vol.% TiC replacement Al-TiC composites. Temperature peak of the no TiC particle replacement composites is higher than the 10vol.% TiC replacement ones shown in Fig.5. These scenarios are corresponding to second stage shown in Fig.2. The reaction between the titanium powder and carbon powder releases a lot of heat and the heat can evaporate the gas such as H_2, H_2O, O_2 out of the compact. The higher the temperature, the more gas can be evaporated out of the compact, the more the final product would be expanded.

However, for the 20vol.% TiC particle replacement composites, reaction between titanium powder and carbon did not occur due to the low temperature peak which did not reach the melting point of AlTi intermetallic. Therefore, this scenario corresponds to the first stage in Fig.2. After the reaction between aluminum and titanium, the layered structure of AlTi was formed and this structure is super porous because the aluminum is still in solid state and a lot of porosity exists in between of the AlTi layers. However, for the second stage where high temperature melted the aluminum to liquid state, and the liquid state can trap the porosity inside. Consequently, volume change in the second stage is normally smaller than the first stage where only reaction between aluminum and titanium occurred. 15vol.% TiC particle replacement scenario is assumed to be the transition stage between the first stage and the second stage because both the synthesized TiC particle and AlTi intermetallic coexisted.

4. CONCLUSION

Aluminum matrix reinforced with TiC particles is synthesized by combustion reaction process. Influence on the temperature peaks and volume change(porosity) of the final products of the different volume percent of TiC particles replacement (no replacement, 10.vol%, 15vol.% and 20.vol%) was systematically investigated. With the increase of the TiC particle replacement, the temperature peaks during the combustion reaction gradually decreases. Also, for the volume change(porosity) of the powder compact after induction heating, with the increase of the TiC particle replacement, the volume change(porosity) first decreases and then increases and the optimal volume percent of TiC particle replacement is around 10% where we should have the least volume change(porosity) to maintain the original shape and the TiC particle can be in situ synthesized from titanium and carbon powder.

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BONDING BETWEEN AL AND CFRTP USING INTERPENETRATING LAYER

Yizhen Zhang

Department of Materials Science and Engineering, University of California, Los Angeles
zhangyizhen1122@ucla.edu

Supervisor: Prof. KOBASHI, Makoto

Department of Materials Process Engineering, Graduate School of Engineering, Nagoya University
kobashi.makoto@material.nagoya-u.ac.jp

ABSTRACT

Laser-induced combustion synthesis with Al-Ti-C mixed powder is used to fabricate protruding anchor layer on aluminium substrate. This type of positive anchor layer is applied to form bonding between aluminium and carbon fiber reinforced polyamide-6, a kind of carbon fiber reinforced thermoplastic (CFRTP). The effects of joining temperature, carbon fiber content and anchor layer microstructure on the tensile strength of Al/CFRTP composites are examined. It is found that when joining temperature increased from 215 °C to 220 °C, for Al/CFRTP with 30 wt.% carbon fiber and anchor structure of Al:Ti:C=1:1:0.8, the tensile strength increased from 17.10 MPa to 20.75 MPa. Compare Al/PA6 with Al/CFRTP, the tensile strength of samples decreased with the addition of carbon fibers. The anchor structure of samples is observed by SEM, which shows that composites with larger average anchor size as well as larger area ratio have stronger bonding between Al and CFRTP.

Undisclosed

(g) The 20th JUACEP Workshop

The 20th JUACEP Workshop
for the summer research course students from University of Michigan and UCLA

Date: Tuesday, August 29, 2017
Venue: NIC Conference Room (3rd floor, NIC)

Timetable

14:30 - 14:35	Opening address by JUACEP Leader
14:35 - 14:50	**(1) Chenfan LIAN**, *Advisor: Prof. Y. Yamada, Mechanical Systems Engineering* "Human Presence Sensing of a Mobile Robot by Using 2D Laser Scanner" ***(Undisclosed)***
14:50 - 15:05	**(2) Erik KRAMER**, *Advisor: Prof. Y. Yamada, Mechanical Systems Engineering* "The Change of Gait Motion During Curvilinear Obstacle Avoidance while Restricted by a Wearable Robotic Device" ***(Undisclosed)***
15:05 - 15:20	**(3) Muzhi ZHU**, *Advisor: Prof. T. Suzuki, Mechanical Systems Engineering* "Vision Based Path Following via Randomized Model Predictive Control" ***(P. 41)***
15:20 - 15:35	**(4) Hao-En CHANG**, *Advisor: Assoc. Prof. K. Matsuoka, Aerospace Engineering* "Dependency of Spark Energy on Deflagration-to-Detonation Transition in a High-Speed Flow" ***(P. 44)***
15:35 - 15:45	Break
15:45 - 16:00	**(5) Yizhen ZHANG**, *Advisor: Prof. M. Kobashi, Materials Process Engineering* "Bonding between Al and CFRTP Using Interpenetrating Layer" ***(Undisclosed)***
16:00 - 16:15	**(6) Zhiwei LIU**, *Advisor: Prof. M. Kobashi, Materials Process Engineering* "Stability of Preform Shape during Reactive Synthesis of Al-TiC Composites" ***(P. 47)***
16:15 - 16:30	**(7) Brian CHANG**, *Advisor: Prof. F. Arai, Micro-Nano Mechanical Science and Engineering* "Pressure Control in an Eye Model" ***(Undisclosed)***
16:30 - 16:45	**(8) Jia WANG**, *Advisor: Prof. H. Amano, Electronics* "Converse Piezoelectric Effect Induced Separation of Thick GaN Film from the SiC Substrate" ***(Undisclosed)***
16:45 - 17:00	Completion Ceremony
17:15 -	Farewell Banquet at NIC Hall

10 minutes presentation + 4 minutes Q&A each

Vision Based Path Following via Randomized Model Predictive Control

Muzhi Zhu
University of Michigan
Mechanical Engineering
JUACEP Program
Suzuki Lab

Outline

2

Motivation

Benefits of autonomous driving

- Improve safety and transportation efficiency
- Increased productivity
- Greater accessibility
- Better road efficiency
- Positive impact on the environment

Ref: [1]

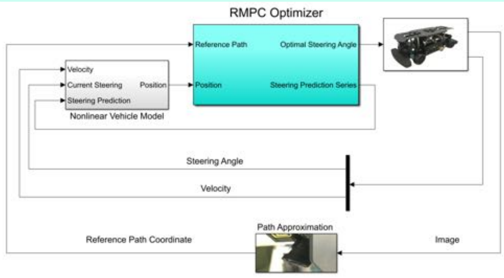
Challenges of autonomous driving

- Localization, Perception, and Control

[1] "Humans are the only ones putting the breaks on self-Driving cars." *The New Economy*, www.theneweconomy.com/business/humans-are-the-only-ones-putting-the-breaks-on-self-driving-cars. Accessed 18 Aug. 2017.

Objective

Propose a steering control method to perform path following using RMPC via camera



Randomized Model Predictive Control (RMPC): A control method that predicts future behaviours of the controlled object based on observation and models, randomly generates control inputs, and decides the optimal input under a predetermined evaluation function

Path Approximation

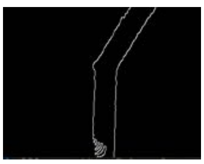
Skewed View

Perspective Transformation

Bird View

Canny Edge

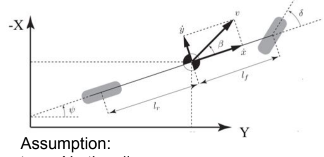
Canny Detection



Parabolic Fit

Reference Path

Kinematic Bicycle Model



Assumption:

- No tire slip
- Ignore steering dynamics

$$\dot{x} = v\sin(\psi + \beta)$$
$$\dot{y} = v\cos(\psi + \beta)$$
$$\dot{\psi} = \frac{v}{l_r}\sin(\beta)$$
$$\beta = \tan^{-1}\left(\frac{l_r}{l_r + l_f}\tan(\delta)\right)$$

Discretize

$$v = \sqrt{\left(\frac{v_r}{2} + \frac{v_f}{2}\cos(\delta)\right)^2 + \left(\frac{v_f}{2}\sin(\delta)\right)^2}$$
$$\psi_{k+1} = \psi_k + \Delta t \cdot \frac{v}{l_r}\sin(\beta_k)$$
$$x_{k+1} = x_k + \Delta t \cdot v\sin(\psi_k + \beta_k)$$
$$y_{k+1} = y_k + \Delta t \cdot v\cos(\psi_k + \beta_k)$$

β	Body slip angle
ψ	Yaw Angle
v, v_r, v_f	Driving Velocity
δ	Front wheel steering angle
Δt	Prediction time step
l_r	center to the rear wheel axis
l_f	center to the front wheel axis

Configuration of RMPC

Given: $\delta(t), v_f(t), v_r(t), (x_{ref}, y_{ref})$

Steering, velocity, trajectory information

Find : $\delta_{k=1}^{N}(k|t)$

Input (steering angle) series

Objective Function

$$J = \sum_{k=1}^{N} w_k \left[\varphi_k^T Q \varphi_k + (\delta_k - \delta_{k-1})^T \bar{R} (\delta_k - \delta_{k-1})\right] + \delta_N^T R \delta_N$$

Error from reference path — Smooth inputs — Limit final input

$\varphi_{kt} = [x_k - x_{ref}] | y_k = y_{ref}$

Subject to: $-30° \le \delta_k \le 30°$

N : Predictive Horizon

Ns : Number of Samples

$Q, R, \bar{R}, w$: Weight parameter

τ: low pass filter time constant

$\delta^i(k+1|t) = \delta^i(k|t) + \Delta\delta^i(k|t)$

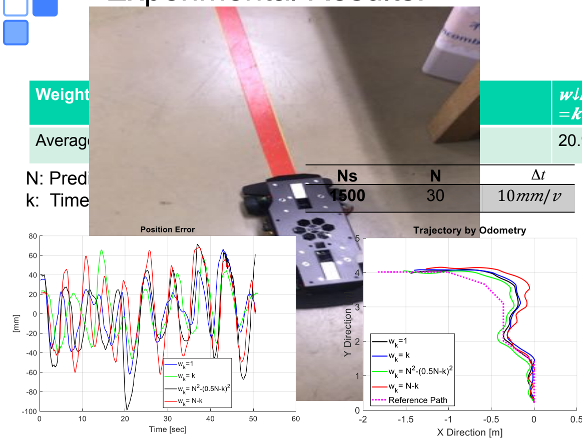
$k = 1 \sim N$

$i = 1 \sim N_s$

$$\delta_{k+1} = \frac{\tau}{\Delta t + \tau}\delta_k + \frac{\Delta t}{\Delta t + \tau}\delta_{k+1}$$

$\Delta\delta^i(k|t)$ uniformly distributed: $-15°$ and $15°$

Experimental Results:



Weight		$w_k = k$
Averag…		20.95

N: Predi…

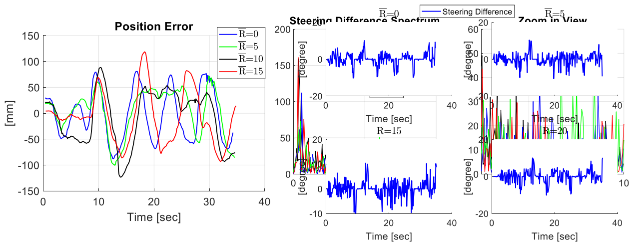
k: Time…

Ns	N	Δt
1500	30	$10mm/v$

Experimental Results: weight: $\bar{R}$

150mm/s

$\bar{R}$	0	5	10	15
Average Error [mm]	41.71	37.77	46.25	39.88



- Consistent average error

Conclusion & Future Works

- Conclusion
  - Proposed a control method for path following using RMPC
  - The effectiveness of the proposed method was verified by experiment
- Future works
  - Solve the nonlinear MPC optimization problem rather than large randomly sampling
  - Varying velocity based on reference path

Acknowledge

- Prof. Suzuki, Prof. Okuda, Prof. Shimizu
- Lab mates
- JUACEP program and Kato san

Thanks for your attention

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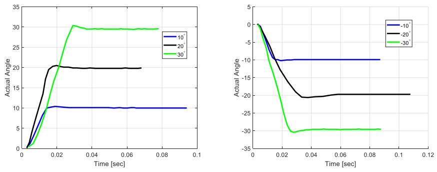
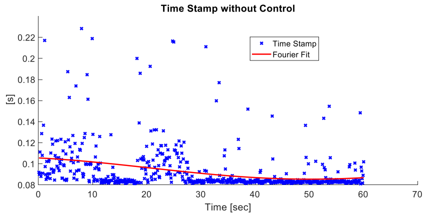
Appendix A: Steering Angle Dynamics

- Ignore steering dynamics





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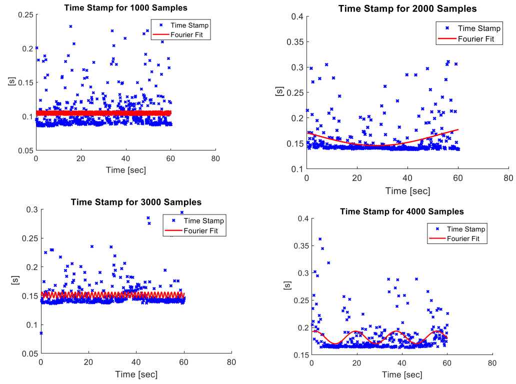
Appendix B: Sampling Computation Time



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Dependency of spark energy on deflagration-to-detonation transition in a high-speed flow

Hao-En Chang
Supervisor: Prof. Ken Matsuoka

Aug 29, 2017

1

Overview

- What is a PDC?
- Deflagration vs. detonation
- DDT process
- Experimental methods & results
- Conclusion

2

Pulsed detonation combustor (PDC)

- Repeated self-sustained detonations
- Design scheme
  - Straight tube with fixed cross-section
  - One end is closed with fuel/gas feeding lines and spark plug while the other end open
- Advantages
  - Higher theoretical thermal efficiency due to higher burning temperature
  - High thrust performance

3

Working of a PDE

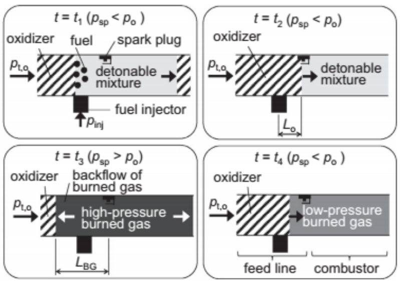


Image source: Matsuoka, K., Muto, K., Kasahara, J., Investigation of fluid motion in valveless pulse detonation combustor with high-frequency operation, *Proceedings of the Combustion Institute*, Vol. 36, Issue 2 (2017), pp. 2641-2647.

4

Deflagration vs. detonation

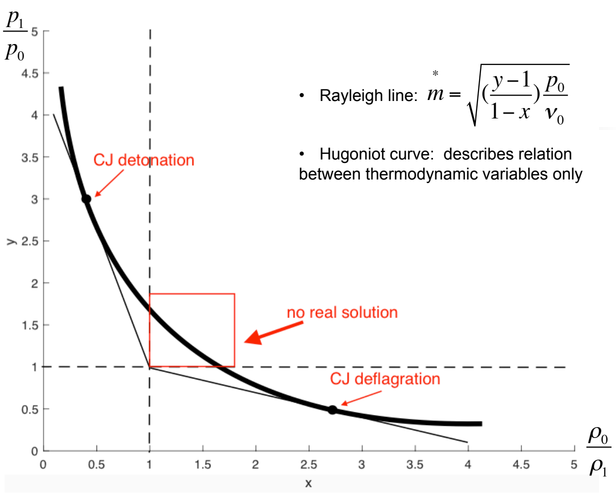
- Deflagration
  - Subsonic propagation
  - Depends also on rear boundary conditions
  - Propagates via diffusion of heat and mass
  - Speed depends on the sqrt of diffusivity and reaction rate
- Detonation
  - Supersonic propagation
  - Drastic change in thermodynamic states
  - Reactants maintain initial state
  - Chapman-Jouguet (CJ) detonation requires sonic condition behind the detonation front

5

Deflagration-to-detonation transition (DDT)

- Cannot be fully described in a single general theory
- Gas dynamic theory of detonation
  - Based on the conservation eqs (mass, momentum, and energy) Links the upstream and downstream equilibrium states across the wave
  - Chapman-Jouguet (CJ) criterion

6



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Enhancement of DDT in a PDC

Existing methods:

- Increase of detonable mixture pressure[1]
- Installation of Shchelkin spiral or obstacles inside the combustor[2]

Objective:

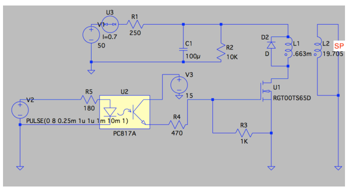
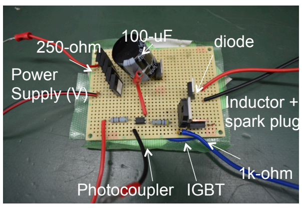
- To investigate the total spark energy on DDT enhancement

[1] Kuznetsov, M., Alekseev, V., Matsukov, I., Do- rofeev, S. (2005). "DDT in a smooth tube filled with a hydrogenoxygen mixture". *Shock Waves*, Vol. 14, Issue 3 (2005), pp.205-215

[2] Ciccarelli, G., Dorofeev, S., "Flame acceleration and transition to detonation in ducts," *Progress in Energy and Combustion Science*, Vol. 34, Issue 4 (2008), pp. 499-550.

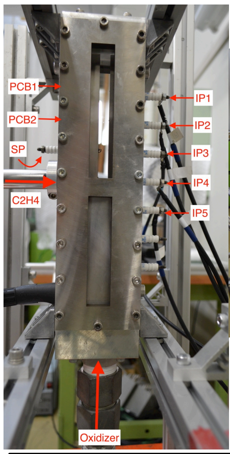
8

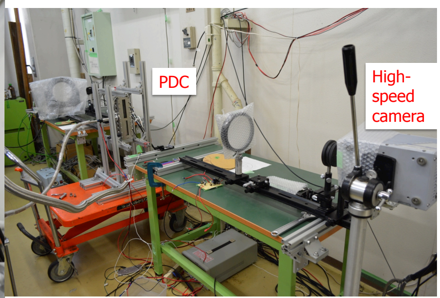
Experimental methods

Spark ignition system

9





Schlieren visualization system

PDC Configuration

10

Experimental results

- Voltage input vs. calculated energy output
- Visualization of DDT
- Flame propagation
- Total output energy on DDT distance and time
- Cross-examination: Theoretical vs. experimental values

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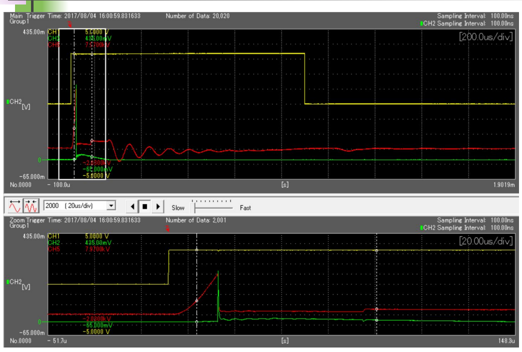
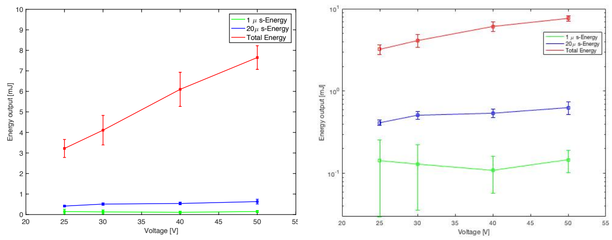
Voltage input vs. calculated energy output



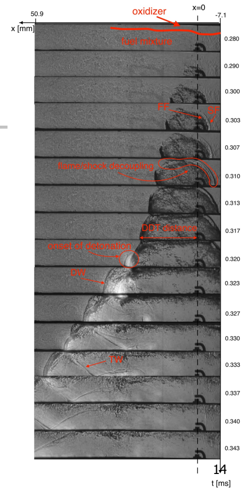
Pulse signal
Voltage
Current



(Log scale in y-axis)

13

Flow visualization



Labels

FF: flame front
SF: shock front
DW: detonation wave
TW: transverse wave

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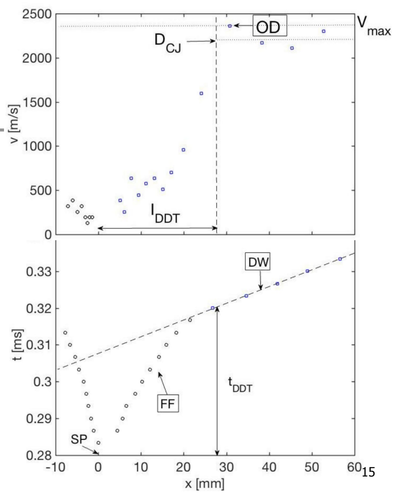
Flame propagation



Labels

OD: overdriven detonation
FF: flame front
DW: detonation wave
SP: spark plug position

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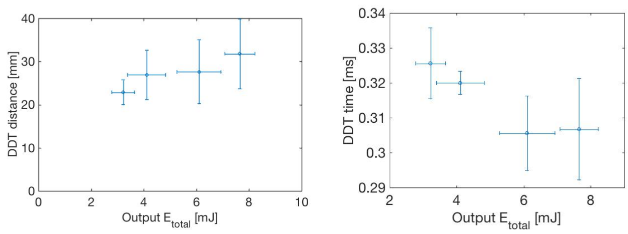
Total output energy on DDT distance and time



Output total E vs. DDT distance

Output total E vs. DDT time

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Theoretical vs. Experimental

	Theoretical (NASA CEA)	Experimental
CJ detonation speed [m/s]	2052.7 + 328.6 = 2381.3	2191.5
Pressure of detonable mixture [MPa]	2.69	2.68

(Temperature: ~300K)

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Conclusion

- DDT enhancement does not depend on the total spark energy output but rather the instantaneous spark energy output at the moment of spark initiation
- Future work to improve our current experiment
  - Calculation of various energy durations at different time intervals
  - Laser ignition system to deposit higher instantaneous spark energy

18

名古屋大学

Stability of preform shape during reactive synthesis of Al-TiC composites

Nagoya University Kobashi & Takata Lab

Presenter: Zhiwei Liu
Department of Materials Science and Engineering, University of California Los Angeles
Instructor: Prof. M.Kobashi
Department of Materials Processing Engineering, Nagoya University

Presentation Outline

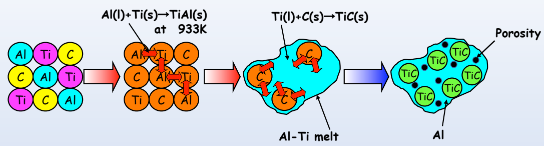
- Introduction
- Experimental Procedure
- Result and discussion
- Conclusion
- Acknowledgement

Introduction

High specific strength
High wear resistance
High temperature strength
Good thermal stability

Combustion reaction synthesis

Definition: combustion reaction synthesis, also known as self-propagating high-temperature synthesis(SHS), uses the heat of reaction that synthesizes intermetallic and ceramics.



Citation: Kwon, Yong-Jai, et al. "Fabrication of TiB_2/Al composites by combustion synthesis of Al-Ti system." Materials Transactions 43.11 (2002): 2796-2801.

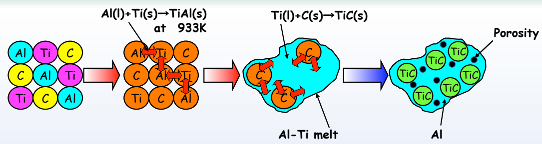
Combustion reaction synthesis

Advantages:
- Short processing time
- Formed thermodynamically stable reinforcement and their homogeneous dispersion in metal matrix leads to better mechanical properties.
- Clean interface between matrix and reinforcement increases their bonding strength.

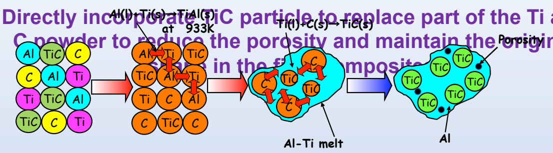
Disadvantages:
- The porosity in the final product is very high which is not beneficial for structural application.

- High heat release leads to the evaporation of gas(H_2, H_2O and O_2), so the final product is very porous.

Combustion reaction synthesis

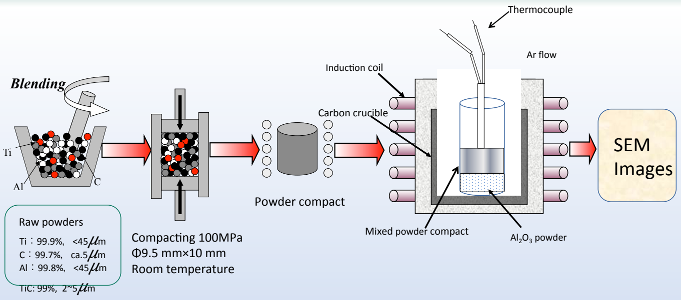


Directly incorporate TiC particle to replace part of the Ti and C powder to reduce the porosity and maintain the original in the final composite



Citation: Kwon, Yong-Jai, et al. "Fabrication of TiB_2/Al composites by combustion synthesis of Al-Ti system." Materials Transactions 43.11 (2002): 2796-2801.

Experimental Procedure



Experimental Procedure

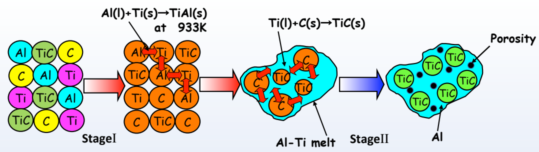
Experiment parameters:

- The mole blending ratio of Al powder, Ti powder and C powder is 1:1:1, so the calculated volume fraction of TiC is 55%
- For using TiC particle to replace Ti powder and carbon powder in the powder blend, 10vol.%, 15vol.% and 20vol.% of TiC particle replacement were designed to evaluate the influence of TiC particle replacement on the temperature peaks and volume change of the final product in the experiment.

Results and discussion

- Reaction mechanism
- Temperature peaks
- SEM characterization
- Volume change

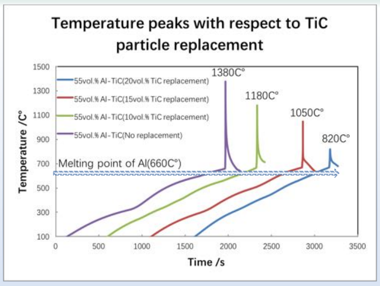
Reaction mechanism

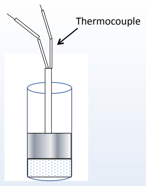


Stage I(973K) ： $Al(s) + Ti(s) \rightarrow AlTi(s) \quad \Delta H = -86.1 KJ/mol$

Stage II (1733K): $Ti(s) + C(s) \rightarrow TiC(s) \quad \Delta H = -184.5 KJ/mol$

Temperature peak with respect to TiC replacement

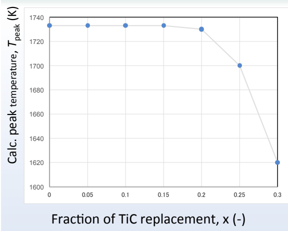




Possible reasons:

- The reaction between Al powder and Ti powder or Ti and carbon powder decreases, so the heat release decreases.
- The directly incorporated TiC particle absorbs heat.

Temperature peak with respect to TiC replacement

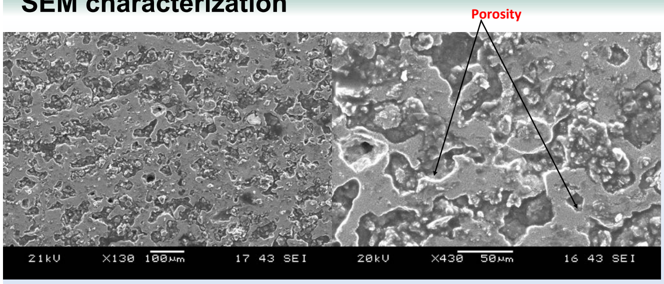


Adiabatic condition: No heat dissipation would be taken into consideration.

It is understood that the T_{peak} is reduced to below 1733 K when x is higer than 0.15~2.0.

TiC replacement	0	10vol.%	15vol.%	20vol.%
Measured	1653	1453	1323	1093
Adiabatic	1738	1738	1738	1730

SEM characterization



55vol.% Al-TiC composite

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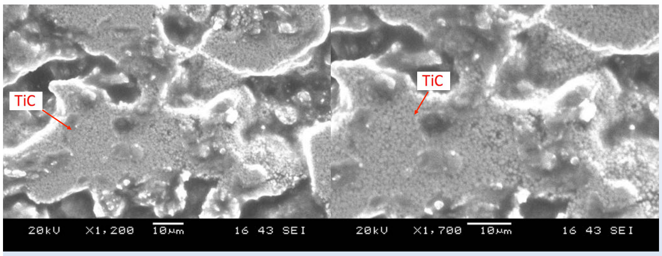
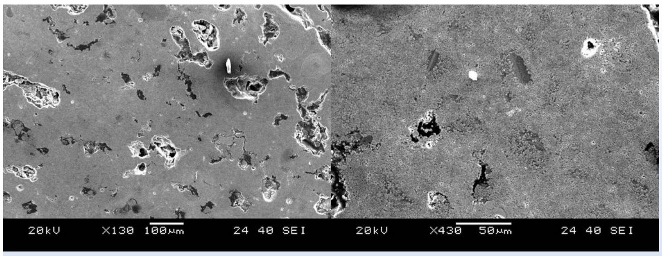
SEM characterization



55vol.% Al-TiC composite

Materials Science and Engineering 14 Nagoya University Kobashi & Takata Lab

SEM characterization



55vol.% Al-TiC composite(10% TiC particle replacement)

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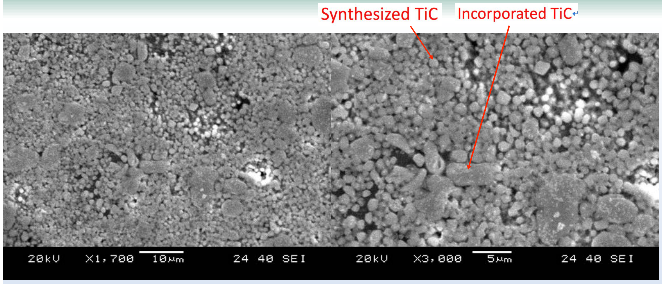
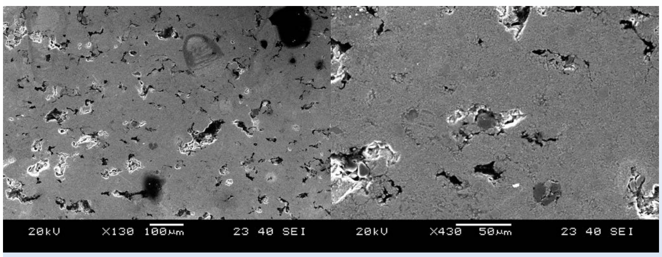
SEM characterization



55vol.% Al-TiC composite(10% TiC particle replacement)

Materials Science and Engineering 16 Nagoya University Kobashi & Takata Lab

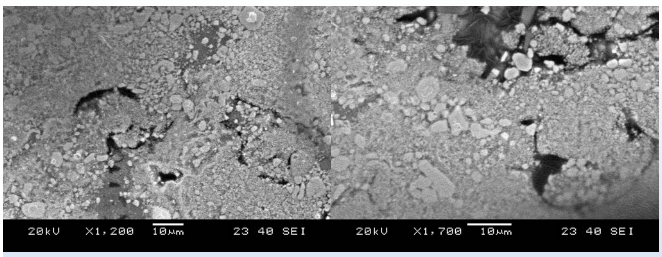
SEM characterization



55vol.% Al-TiC composite(15% TiC particle replacement)

Materials Science and Engineering 17 Nagoya University Kobashi & Takata Lab

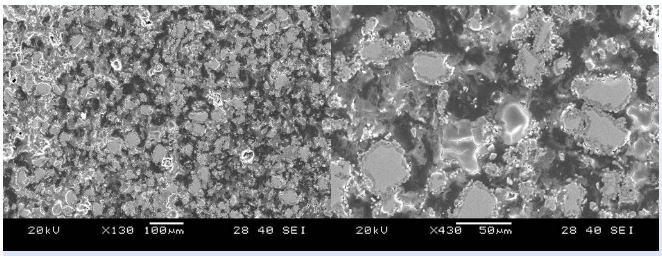
SEM characterization



55vol.% Al-TiC composite(15% TiC particle replacement)

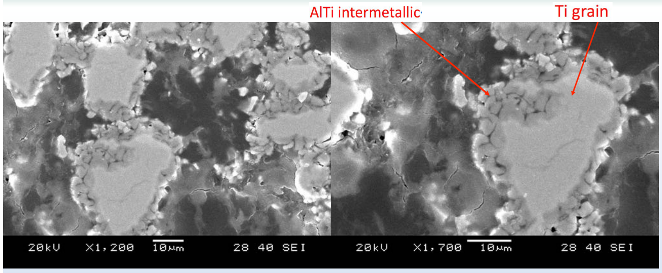
Materials Science and Engineering 18 Nagoya University Kobashi & Takata Lab

SEM characterization



55vol.% Al-TiC composite(20% TiC particle replacement)

SEM characterization



55vol.% Al-TiC composite(20% TiC particle replacement)

Volume change

Before Sintering

After sintering (No replacement)

After sintering (10% TiC particle replacement)

After sintering (15% TiC particle replacement)

After sintering (20% TiC particle replacement)

Volume change

55vol.% Al-TiC (No replacement)	Height(mm)	Diameter(mm)	Volume(mm³)
Before sintering	7.30	9.65	533.64
After sintering	8.43	10.55	736.54

Volume increase:
$\Delta V_T = V_2 - V_1 / V_1 = 38.02\%$

55vol.% Al-TiC (10% TiC particle replacement)	Height(mm)	Diameter(mm)	Volume(mm³)
Before sintering	7.30	9.65	533.64
After sintering	8.17	9.92	631.12

Volume increase:
$\Delta V_T = V_2 - V_1 / V_1 = 18.27\%$

Volume change

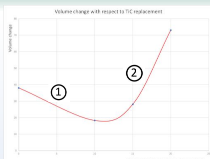
55vol.% Al-TiC (15% TiC particle replacement)	Height(mm)	Diameter(mm)	Volume(mm³)
Before sintering	7.65	9.65	559.22
After sintering	8.55	10.33	716.20

Volume increase:
$\Delta V_T = V_2 - V_1 / V_1 = 28.07\%$

55vol.% Al-TiC (20% TiC particle replacement)	Height(mm)	Diameter(mm)	Volume(mm³)
Before sintering	7.35	9.65	537.29
After sintering	9.73	11.04	930.93

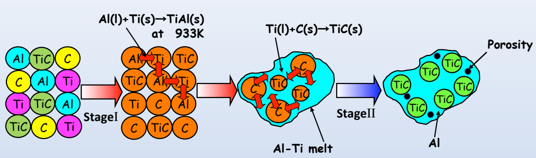
Volume increase:
$\Delta V_T = V_2 - V_1 / V_1 = 73\%$

Volume change



Explanations:

- Descending curve: Higher TiC replacement→less heat released in the reaction→less gas evaporated→less volume change of final product
- Ascending curve: No formed TiC particle, only reactions between Al and Ti powder, layered structure formed, porosity can exist in between, normally higher volume change.



Conclusion

In order to reduce the porosity in the fabricated Al-TiC composites and maintain the original precursor shape after the combustion reaction, different volume fraction of TiC are directly incorporated to replace the corresponding amount of Ti and C powder.

With the increase of the replacement of TiC particle:

- The temperature peak during combustion reaction decreases gradually.
- The volume change(porosity) first decreases and then increases and the optimal volume fraction of TiC particle replacement is around 10% where we have the least volume change to maintain the original shape and TiC particle can be in situ synthesized.

Acknowledgement

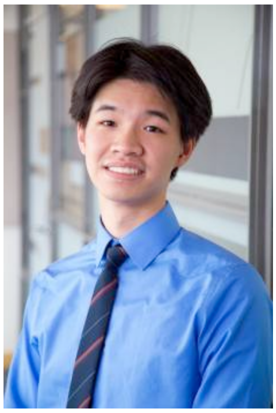
- Thanks to Prof. Kobashi for accepting me to stay in your research lab. Prof. Kobashi always has a clear sense about where the research orientation should move on. Every time I got trouble with my research, he could always give me the most right assistance and guidance.
- Thanks to my TA Aoki san. During the two months research life here, he almost accompanied me with any one of my experiment, teaching me how to use the equipment and helping me to do the data analysis and curve analysis.
- Thanks to all of the rest of the lab mates and JUACEP program members and officers. Your warm welcome and selfless help make a have a better transition to this lab. And this lab always gives me a feeling of being at home. Without your guys care and attention, my exchange life here would not be so enjoyable and fascinating as I was living.

<3> Reports and Questionnaires on JUACEP

(a) Findings through JUACEP

(b) Questionnaires

Findings through JUACEP



Name: Brian Chang
Affiliation at home country: University of Michigan, Department of Electrical Engineering and Computer Science
Participated program: Summer Course 2017

Research theme: Pressure Control in an Eye Model
Advisor at Nagoya Univ: Prof. Fumihito Arai
Affiliation at Nagoya Univ: Department of Micro-Nano Mechanical Science and Engineering

Japanese language and culture was something I had interest in from time to time. Before coming to Japan, I had never learned Japanese. My first few days, the language barrier made me not so comfortable going out alone. I wanted to be accompanied by somebody, thinking that being with somebody who also did not know any Japanese was less embarrassing than being alone. Knowing some Chinese characters, I could deduce what some of the signs and labels written in kanji were saying, but the hiragana and katakana were completely foreign to me. After taking the Japanese course, I was comfortable reading hiragana and katakana, and could function basically (e.g., order at a restaurant, go shopping) using Japanese. I feel that if I were to spend a year in Japan, I would become able to speak decent Japanese.

The first weekend was dedicated to exploring Nagoya. In Nagoya, I explored the Sakae area, ate unagi at Horaiken (a very famous unagi restaurant), and visited Atsuta Shrine and Nagoya Castle. During later weekends, I traveled to Tokyo, Osaka, Yokohama, Kyoto, Mt. Fuji, Shirakawa, and Kanazawa. Activities which I checked off my bucket list included: climbing to the top of Mt. Fuji, dining at a Michelin star [ramen] restaurant in Tokyo, riding on the Shinkansen, going up the Tokyo Tower, and eating fugu. Other fun activities included taking cruises at Osaka (including Santa Maria at sunset), visiting the Umeda Sky Tower Observatory in Osaka, riding the Tempozan Ferris Wheel at Osaka Harbor, watching the Shibuya Crossing from the second floor of Starbucks in Tokyo, eating fresh sashimi at the Tsukuji Fish Market in Tokyo, seeing the Pikachu festival at Yokohama, and much more. This most stressful, yet most rewarding activity was climbing to the top of Mt. Fuji. My friends and I spent almost 10 hours of the night climbing, with the goal of arriving at the top in time to see the sunrise. Although we were unable to see the sunrise due to being unlucky with the weather, I have now done per the Japanese saying “A wise man will climb Mt. Fuji once”.

Research, of course, was an important part of the program. I participated in this program with close to zero research experience, with the hope of gaining such experience. My project involved programming a microprocessor to help a pump maintain fluid pressure at a desired level. Because research was new to me, it would often feel like I was being thrown into the water and expected to figure out how to swim on my own. However, I felt that this was an important skill to learn, and it was not one which could be very easily obtained from the classroom. I learned a lot from the experience, but wish the program was longer, as 10 weeks was a bit too short to complete a substantial project. Although research was the main purpose of my visit, my professor understood that part of my time in Japan was for exploring the country and experiencing the culture, thus he was very accommodating in that respect. While the last few weeks felt like cram time, overall, this program provided a research experience which still allows for a good work-life balance.

What I will miss about Japan is the food, the reliability of public transportation, and the people I met here. Aside from gaining research experience, I also got to explore many places which I have wanted to visit. I am very glad that I chose to participate in this program, as it will be difficult for me to travel like this once I enter work life. Overall, I would recommend this program to anybody who wants a research experience abroad that comes with a lot of fun.

Findings through JUACEP

Name: Hao-En Chang
Affiliation: Department of Aerospace Engineering at the University of Michigan
Participated program: Summer Course 2017

Research theme: Dependence of spark energy on deflagration-to-detonation transition in a high-speed flow
Advisor at Nagoya Univ: Prof. Ken Matsuoka
Affiliation at Nagoya Univ.: Department of Aerospace Engineering

The moment I found out there was an opportunity to conduct research in Japan this summer I immediately knew that I wanted to come. And my experiences here over the last two months have shown to me that it was inarguably one of the best decisions I'd ever made in my life.

Before coming to Japan this summer, I actually had made several short visits to the country over the years. But I know my visit this time was different from the rest because it allowed me to experience the country more in-depth with the time we were given to stay. More importantly, it was also different this time because I would be studying and working on research while adapting to an academic environment previously unfamiliar to me. In fact, the majority of my time here was spent on research. One of the things I was most impressed by the academic curriculum in Japan is the early exposure to laboratory for engineering students. While in the U.S we are not required to have research experience during our undergraduate, Japanese students start going to lab almost as a full-time during their last year in undergraduate and are usually required to submit a research thesis upon graduation. Therefore, by the time they are in master's programs they would already have a great understanding of how to work things around in a lab. I personally think this is better for students who know early on that they want to focus on research for their later studies.

If somebody asked me what is the one rule Japanese people will never break, I'd say it's the practice of always being on time. As a matter of fact, I was never late to my appointments while in Japan except one instance when I misread the meeting time. Similarly, there was never a time I could think of where I had to wait for whomever I was meeting with. My guess is this could somehow be related to the punctuality of its public transportation system. Since most people commute to work or school on a daily basis and the trains are rarely delayed, they can't afford to be late because a minute late could end up costing hours of their time. Or maybe it's just one of the deep-rooted cultural values that has been passed on over many generations in Japan. Either way I really enjoy having faith in Japanese people's sense of time.

To be honest, I didn't know much about Nagoya before coming here. But I dare to say that I really enjoyed living in this city. It's not so overwhelming in terms of size or population like in Tokyo and yet there is still a lot to offer such as the abundance of delicious food and entertainment activities. My favorite food from Nagoya is the unadon served in Hitsumabushi style. It is a little expensive but will 100% excite your taste palette. Obviously I had also taken the opportunity to explore many places in Japan on weekends. I must say the most memorable one was the audacious climb of Mt. Fuji. Four other JUACEP students and I decided to take on the challenge and climb Mt. Fuji at night in total darkness. Our hope was to catch a glimpse of the sunrise in the early morning when we estimated to summit. It took us 9.5 hours without any sleep to make to the top while constantly being braced by cold wind. Although I'm proud to say that I've seen the world atop Mt. Fuji I most definitely would not attempt climbing it again since there goes the saying, "A wise man climbs Fuji once. Only a fool climbs it twice."

The best thing about summer in Japan is that it is filled with cultural festivals (matsuri) and fireworks where you can also try a lot of amazing street food. I had the chance to participate in a few of them to immerse myself in the atmosphere of joy and festivity, which is one of the best experiences I'd had in Japan. With that, I'm forever grateful for my time and learning this summer in Japan.

Findings through JUACEP

Name: Muzhi Zhu

Affiliation at home country:
Mechanical Engineering, University of Michigan
Participated program: Summer Course 2017
Research theme: Vision Based Path Following via Randomized Model Predictive Control
Advisor at Nagoya Univ: Prof. Tatsuya Suzuki
Affiliation at Nagoya Univ.: Mechanical Engineering

JUACEP program has been a wonderful experience for me. I have always been interested in Japanese history, traditional culture as well as pop culture like manga, and of course, Japanese food. Thus it is a great opportunity for me to experience Japan. Through the communication with lab mates, faculty advisor, and travelling around, I got the chance to learn more about Japan.

I joined Prof. Suzuki's lab to work on path following real time control. It is the first time for me to use model predictive control method on an embedded system platform. It enhanced my c++ coding skills, theory background in vehicle dynamics and control, and computer vision. Through the summer's work, I learned practical knowledge regards modeling and control that I will further utilized and developed in my graduate study and work.

Lab mates are friendly and hospitality. Our lab has more than 20 students, even though not every one can speak fluent English, we can still communicate with each other well. During the program, we went out for dinner and bowling occasionally. It is really an interesting and memorable experience talk to person with different culture background.

During my stay in Japan, I visited major cities like Tokyo, Osaka, and Kyoto to view city land markers of Japan. I also climbed Fuji Mountain, visited country area like Takayama, Nara, and Shirakawa to appreciate the beautiful natural scenery and historical buildings.

I truly enjoy my staying in the program and I would highly recommend the program to anyone who is interested in Japanese culture or cross culture experience in general.

Findings through JUACEP

Name: Chenfan Lian
Affiliation at home country:
Department of Mechanical Engineering, University of Michigan – Ann Arbor
Participated program: Summer Course 2017
Research theme:
Human presence sensing of a mobile robot by using 2D laser scanner
Advisor at Nagoya Univ: Prof. Yoji Yamada
Affiliation at Nagoya Univ.: Mechanical Systems Engineering

During this two-month stay in Nagoya University for the JUACEP program, I not only improve my academic research ability by taking part in a topic focusing on human sensing and navigation of the mobile robot, but also spend time exploring the Japanese culture and social life.

At the beginning of the research work, everything seemed totally unfamiliar to me. I realized that I had to work very hard to accomplish my assigned task. Fortunately, Professor Yamada and my TA Mr. Kim kindly offered me a lot of guidance about the background knowledge. At a result, I was able to conduct a successful experiment.

Also, the activities that the JUACEP office arranged are all very meaningful and interesting. For example, the field trip to Toyota factory introduced us the great history and future of the automotive industry. The engine workshop provided us a great hand-on experience.

In the same time, we have chances to travel around Japan on holidays. Communicating with local people helped us learn more about the Japanese culture.

In a word, this summer program is amazing!

Photo: Field trip to Toyota Museum

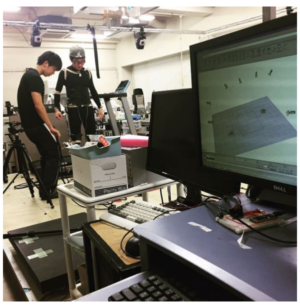
Findings through JUACEP

Name: Erik Kramer
Affiliation at home country (Dept & Univ): Mechanical and Aerospace Engineering at UCLA
Participated program: Summer Course 2017

Research theme: The Change of Gait Motion During Curvilinear Obstacle Avoidance while Restricted by a Wearable Robotic Device
Advisor at Nagoya Univ: Prof. Yoji Yamada
Affiliation at Nagoya Univ. (Dept.): Mechanical Science and Engineering

The Japan-US Advanced Collaborative Education Program has been one of the most fulfilling and exciting summers of academic career. It offers a rare opportunity for engineering graduate students to experience a study abroad lifestyle while still advancing their research. During the course of the summer I was able to design, perform, and analyze an experiment on the effects of a wearable robotic device on the ability of an operator to turn and avoid obstacles. This work is directly related to my own research focus at UCLA and will without a doubt be used to strengthen my PhD dissertation in a few years time. Along with the immensely helpful knowledge and experience that came from my work within the framework of the summer program, I am working with my lab at Nagoya University to submit my results to a conference for publication. A successful conference proceeding greatly strengthens my standing and helps me move closer to my desire to become a professor in the future. I could not have hoped for a better outcome to this summer. Despite my lack of knowledge of the Japanese language, my labmates and advisor were very welcoming. I quickly felt at home in my lab, working side by side with some of the other students as if I had always been there. It was great to be in a laboratory environment with hard working staff that were friendly and open to socialize outside of work.

While the research was the defining factor for my participation in this program, this experience had a lot more to offer! The trip to the Toyota manufacturing plant was especially exceptional. It was both informative and awe inspiring to see first hand how the robotic arms I work with every day in my research can be scaled to massive manufacturing sizes while still working in complete harmony. The workshop on internal combustion engines was also a lot of fun as well as very insightful. Outside the scheduled JUACEP activities I was also able travel around Japan and see many places I wanted to visit. During my time here I visited nearly every place I've dreamed of going to in Japan, from Miyajima and Hiroshima to Tokyo and Yokohama as well as numerous places in between. The city of Nagoya is a great central hub to branch out and visit numerous sightseeing locations. Life in Nagoya itself, though a little scary at first due to the language barrier, ended up being very nice. The Nagoya University housing was modern and well kept up. It was a pleasure to live there for the duration of my stay. While the cultural differences were a bit worrisome at first, overtime and through the knowledge gained from the program's Japanese language course, Nagoya and Japan began to feel like home. Overall, the entire program was a great balance of weekly lab research and exploring Japan on the weekends. It was an experience I will treasure for many years to come.


Amazing Japan where modern and tradition meet up

Name: Jia Wang

Affiliation at home university:

Department of Materials Science, UCLA

Participated program: Summer Course 2017

Research theme: Converse-piezoelectric-effect induced separation of thick GaN film from the SiC substrate

Advisor at Nagoya Univ: Prof. Hiroshi Amano

Affiliation at Nagoya Univ.: Electrical Engineering

JUACEP program is really special to me. Since I have been engaged in the GaN research for several years where Prof. Amano has led the pioneering efforts in this field, I read many of Prof. Amano's publications earlier than he was awarded the Nobel Prize in Physics 2014, and admire his contribution to the development of GaN semiconductor, which led to the commercialization of today's blue and hence white-light LEDs. Thanks to the JUACEP program, I am much honored to have this exceptional opportunity to join Amano group and carry out interested research in the lab. In addition to numerous advanced experimental apparatus and abundant academic resources, I also enjoy exchanging latest research information in the field with many expertized students here. Though GaN achieves dominant role in the illuminating LED market today, it is still far from realizing its true potential due to many materials-related issues. I recalled that during the JUACEP-organized field trip to Toyota exhibition center, the power inverters displayed for the electric vehicles are merely based on Si and SiC semiconductors, if those issues with GaN can be addressed, GaN will dominate the future market in these power electronics applications. However it is not an easy path, therefore the lab members are working hard to tackle these challenges from every possible angle of study. I am deeply impressed by the spirit of diligence demonstrated by the faculty and students in the lab, including Prof. Amano, who would always work in his office till very late night unless having business trip. I think this may account for why Japan has nurtured so many distinguished scientists, with Nagoya University alone enjoying six Nobel Laureates.

Other than experiencing modern science and technology in Japan, I'm also obsessed with traditional Japanese culture.

For example, during weekend trips I like to explore those ancient Japanese castles, a kind of magnificent architecture unique in Asia, so far I've visited Nagoya-jō, Osaka-jō, Niiō-jō in Kyoto, Himeji-jō, Hiroshima-jō, Edo-jō ruins in Tokyo. Besides castles, Shinto shrines are also aboriginal and special. It is the place where one can feel the tranquil peace with nature. I toured different style of shrines like Hachiman shrines, Inari shrines. Among them, the style of Ise shrines left me deepest impression. The design of simple geometry with original wooden color, somehow resembling Scandinavian-style cottage, makes one understand the true harmony between human and nature.

Besides traditional buildings, performance art is appealing. Although it is pitiful that I was not able to watch sumo wrestling during the Tournament in Nagoya since the ticket is in so high demand, I did enjoy Giōn-matsuri parade in Kyoto and two shows of traditional Noh operas at the Nagoya Nōgakudō in July and August. Especially, the classical lion dances in the famous opera *Shakkyō* is so rhythmic and exciting. When I came out of the opera house and walked to Sakae at the heart of downtown Nagoya, I happened to come across World Cosplay Summit 2017, where thousands of young people dressed up in bizarre costumes. It occurred to me that how similar those colorful hairs of cosplay fans are to the red and white wigs wore by Noh players on the opera stage, where traditional beauty and modern fashion meet up in a special way. As the new culture is inheriting and evolving from the old ones, it is amazing to see the new culture thriving while the old culture still gets carefully preserved and respected in Japan.

It is the JUACEP program that fulfill my desires of academic exchange in a world-renowned research group on GaN semiconductor. It is also the JUACEP that enables my deep exploration of these unique cultural stuffs during this meaningful summer. I would like to express my truly gratitude: JUACEP and Nagoya University, arigatō!




Findings through JUACEP

Name: Zhiwei Liu
Affiliation at home country:
Materials Science and Engineering, University of California Los Angeles
Participated program: Summer Course 2017

Research theme:
Stability of preform shape during reactive synthesis of Al-TiC composites
Advisor at Nagoya Univ: Prof. Kobashi
Affiliation at Nagoya Univ.: Materials Science and Engineering

This summer, I took the research internship program from University of California Los Angeles to Nagoya university and stayed there for two months. I feel so lucky to be chosen to participate this program for my summer because I got improved a lot in my academic performance, also, my travelling experience here and deep communication with local Japanese people dramatically sharpen my understanding about Japanese culture.

For the research, my research orientation here is close to the one that I had at UCLA, so my transition to the lab here is smooth. During the two months of my research life, my host professor was very helpful and gave me a lot of assistance and guidance every time I had trouble with my research. Also, my TA was super kind-hearted who helped me a lot in using equipment and data analysis. Although we had a little bit difficulty in communication, we could finally make it and I thought his English improved a lot by constantly practicing with me. My final experimental result here is satisfying and I am now capable of using more equipment than before. Also, I took the Japanese course here. Although the length of the Japanese course is only one month with ten lectures, I now can do basic Japanese communication and know how to study Japanese in the later stage of my life.

For the life here, Nagoya University is not that large but you can basically access all the resources you want. In addition, the transportation here is convenient and we have a subway station just inside the campus which makes our life much easier. Travelling around also occupies a certain amount of our time here. During the two months, I went to Ise, Kyoto, Fuji mountain and Tokyo. Japan is really suitable for travelling! Kyoto is the representative of history part of Japan and you can see different kinds of temples, shrines there. Fuji mountain stands for the natural wonder part of Japan and climbing to the top of the mountain indeed consumes a lot of energy and time. Ginza in Tokyo stands for the modern part of Japan and you can basically buy all the luxury brands there. Except for Ginza, there are a lot of other places that are worth paying a visit to in Tokyo! Also, Shinkansen can basically take you to anywhere although the ticket fare is not that cheap.

To sum up, I feel so satisfied with this summer exchange program and I am sure I will come back to Japan for travel in the future.

Findings through JUACEP

Name: Yizhen Zhang
Affiliation at home country: Materials Science & Engineering, UCLA
Participated program: Summer Course 2017

Research theme: Bonding Between Al and CFRTP using interpenetrating layer
Advisor at Nagoya Univ: Prof. KOBASHI, Makoto
Affiliation at Nagoya Univ.: Materials Science and Engineering

It has been exactly two months since I came to Japan on June 19th. Life here is so amazing that I could not ask more. Every day here is like an adventure with a lot of fun.

Before I came to Japan, I cannot speak Japanese at all, even one simple sentence. The Japanese classes provided by JUACEP program were so helpful that we were able to know all the 50 hiragana and katakana, and also many basic expressions like how to greet, count numbers and tell about weather. I was so excited when I found that I could understand others better after learning.

I am grateful to be a part of professor Kobashi and professor Takata's laboratory. I attend group seminar every Thursday. All of lab members make slides with English for us to better understand their topics. Because of that I can follow the presentations well and ask questions. Professor Kobashi is so thoughtful that he is always patient with explaining research details to me. My teaching assistant is also very helpful and patient. Because of them, I was able to master all the necessary experimental skills in the first two weeks. We also have meetings several times to discuss about my research progress. Besides, my other labmates are all very friendly to me and willing to help me out when I face some troubles. We get along well with each other and have become very good friends. They even held a welcome party for us and it felt so good drinking and having barbecue together.

I was also able to visit several places in Japan such as Takayama, Shiragawa-go, Kyoto, Osaka and Tokyo with other program members. I was impressed with not only the beautiful sceneries but as well the attractive Japanese culture. Japanese people are always very considerate to others, which, I think, is what I should learn from people here. Every time I go to cafeteria with my labmates, we will always wait until all of us get food. Japanese people always think of others so that Japan has the most amazing social order. A very intuitive view about this point is that every place here is so clean, streets, restaurants, restrooms, and so on. When students have food in the cafeteria, they will even clean up the table before leaving. As a result, life becomes easier for ourselves.

I would strongly suggest you to apply for the homestay program held by hippo organization. It is a two-night, three-day program that allow you to live in a local Japanese family and spend time with them. My host family, Goto family is so nice to me. They took me to Inuyama castle, cooked delicious food for me, and watched animations with me. It was so good to have a Japanese family and I like my two Japanese sisters so much. They even took me to attend important family events, making me feel at home. The warm atmosphere was unforgettable.

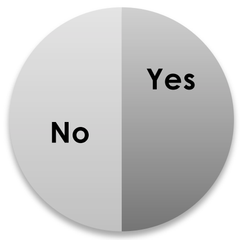
Too many things happened in the past 8 weeks that I cannot write down them all in one page. So here I just want say thanks to Nagoya University and JUACEP program for providing me with this invaluable chance. I have already fallen in love with Nagoya city so that I am thinking about now to find a job in Japan in the future. I will always carry those precious memories with me. I hope I can visit Japan again in the future and see my friends here again.

(b) Questionnaires

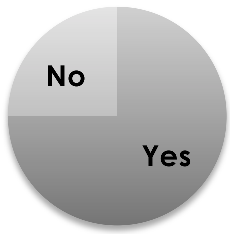
For Q1-4, we asked the same questions BEFORE and AFTER the program.

Q.1: Are you interested in studying at a Japanese university for PhD?

Before

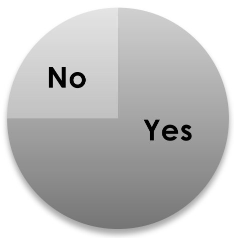


After



Q.2: Are you interested in working at a Japanese company in USA?

Before



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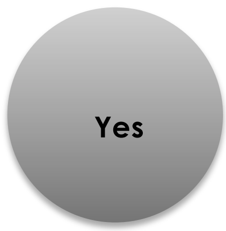
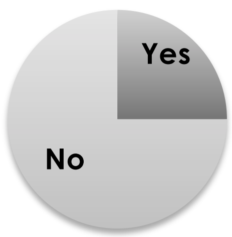


Q.3: Are you interested in working at a Japanese company in Japan?

Before



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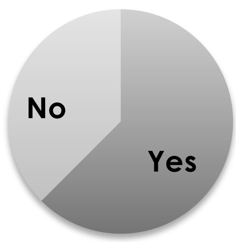
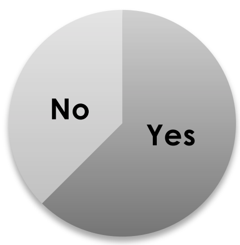


Q.4: Are you interested in working at a non-Japanese company in Japan?

Before



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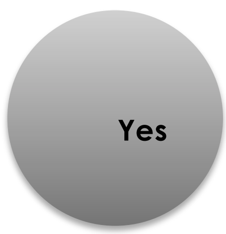


Q.5: In what did you find difficulty? What could be improved? (Excerpts)

[Language barrier]

- Language barrier can sometimes cause communication issues, but it helped a lot since I know that meaning of kanji, thus in general it is not a big problem as well.

- From my experiences of traveling around Japan, I'd say the biggest hardship was communication. A lot of times I felt lost because I couldn't speak Japanese and a lot of them didn't know enough English to respond to my questions or concerns. Usually I have to use very basic English to express myself so I think it's rather hard to have a deep conversation with the locals here who don't speak the same language as me. But this also fuels my motivation of wanting to improve my Japanese.

- As expected the language barrier was the most difficult part of the overall JUACEP experience. I was lucky to work in a lab where many lab mates spoke some level of English, so my research was not hampered by this disadvantage. Life outside the lab however was sometimes difficult, especially for someone who entered the program with little to no knowledge of Japanese. I believe this could be slightly remedied by modifying the Japanese class curriculum to focus more on vocabulary, grammar, and other phrases which are helpful in daily interactions. I believe we spent too much time in class learning hiragana. It is not very helpful to be able to read hiragana when you do not know what the words you are reading mean.

[Communication opportunity]

- I found difficulty in communicating with Japanese people sometimes since I do not know Japanese before I came here. However, the Japanese classes were very helpful to us that we now know some basic expressions.

- I wish that there could be more female participants in this program, because there might be some inconvenience during daily life if you only have male partners in the same program.

- I hope that this program can provide more open lectures which are taught in English.

[Research circumstances]

- If there was anything that could be improved about my experiences here this summer I think it would be the time management of my research. Since we only had 10 weeks to work on our research project, it is especially important that we set out the agendas for each week in order to ensure that we reach the goals timely and accordingly. This way we won't have to cram everything in the very last minute.

- Research internship is quite challenging. However, the professor and TA are very kind of offering help.

- The only real downside to this program was its duration. It is very difficult to design a research objective, execute an experiment, and analyze data in the course of two and a half months. While I was able to obtain results in my time here, I felt very rushed (especially towards the end). I think it would be a good idea for the professors to discuss research plans online prior to the participants' arrival in Japan. If I had a solid direction from previous online discussions in my first few weeks here, then I believe I would have felt less rushed overall.

- The thing I would consider changing is the length of the final JUACEP Workshop presentation. Though the presentation has not occurred yet at the time of writing this, I have done a practice presentation that took twice the amount of allotted time for the Workshop. I think that ten minutes for two and a half months worth of work is a little too short.

[Financial]

- Only complaint is about how non-transparent the dorm fees were. The total cost would have been okay if all fees were disclosed to us clearly and correctly from the very beginning.

[Program period]

- As for the suggestion, I think that ten-week-period might be a little tight to complete a high quality research project. There is more collaborative research work needed to carry out in order to warrant a nice paper to publish.

- The program may improve by adding more duration options, for example provide short term as the 10 weeks programs now and longer terms for a semester.

- In addition to the 10-week summer program, it would also be great to offer a 6 or so month program, as is offered to Nagoya University students.

Q.6: Write comments freely.

- Great experience, great program administrators, thanks for the coordination work.

- There was nothing I didn't like about the JUACEP this year. I think the programs such as the Toyota Factory tour and Japanese language course were all very well prepared and meaningful, which I enjoyed a lot.

- I want to extend my sincere thanks to JUACEP for giving me the opportunity to experience the cultures of and study in Japan. All of this wouldn't have been possible without the support of JUACEP. Also, I want to thank the members of Propulsion and Energy Systems Engineering Group of Nagoya University for working closely with me on research this summer, especially Professor Ken Matsuoka who was my research faculty supervisor throughout the entirety of this program. I really enjoyed my two months in

Japan and will definitely come back again. Thanks again for all the wonderful experiences, memories, and the good food. See you soon!

- I think this exchange program is beneficial for harvesting international experience and students outside Japan can take advantage of this opportunity to experience the Japanese style of teaching, academic research and authentic Japanese culture. Also, this kind of exchange activity can also enhance the relationship between Nagoya University and UCLA.

- This is one of the best experiences in my life. I enjoyed my stay here very much. People I met in Japan are all so nice to me especially my lab partners. I really hope that more and more students can join this amazing program in Nagoya.

- Taking part in the JUACEP program is one of the most valuable experiences in my life. Thank you all for offering us a good chance to study and have fun at the same time in Japan.

- I would like to thank JUACEP Office very much for her coordinating efforts throughout the entire program. Every program in the JUACEP is well designed and carried out.

- I think a good idea would be for there to be something where past participants can provide tips and recommendations to future participants prior to their arrival. This can include, but would not be limited to: things we wish we knew about prior to arriving in Japan, restaurants to try, attractions to visit, tips for visiting certain cities, etc. For example, I wish I knew about the JR pass so that I could consider getting it before I came to Japan. I would assume other participants may also be interested in knowing about tax-free shopping and many of the opportunities which may allow foreigners to save on their travel costs.

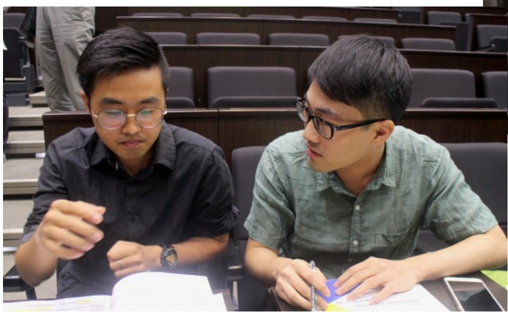
<4> Appendix

(a) Photo Collection

(b) Handout Materials

(a) Photo Collection

Orientation & first meeting with lab members, June 20



The 43rd JUACEP Seminar by Prof. Kurabayashi, June 29

Meet-up for US & JP JUACEP participants, June 30

University dormitory 'Residence Yamate'

Off-time

Climbing Mt. Fuji

At a yakiniku restaurant

With Supervisor

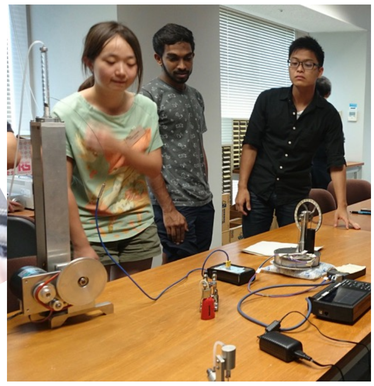
Party of US & JP JUACEP participants

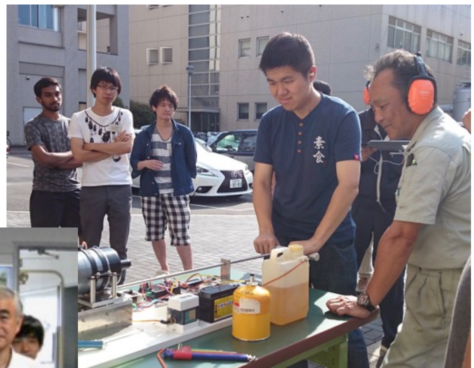
Hands-on exercise 'Internal Combustion Engine', July 4 & 6

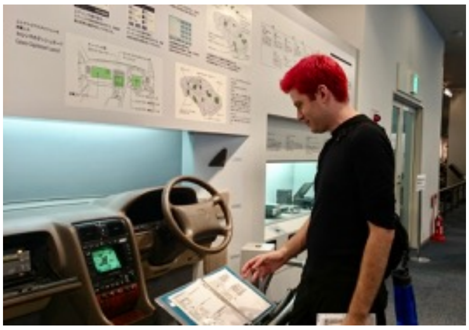






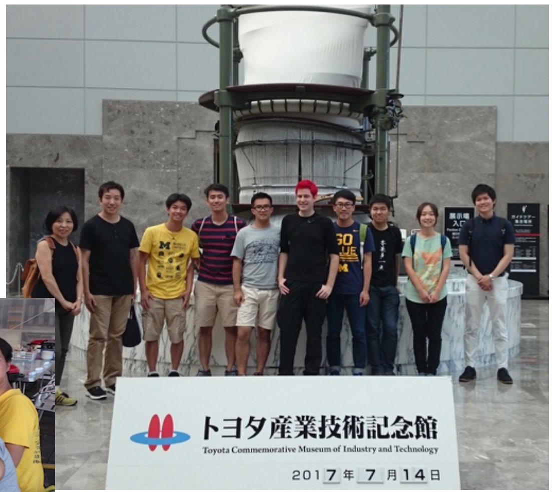





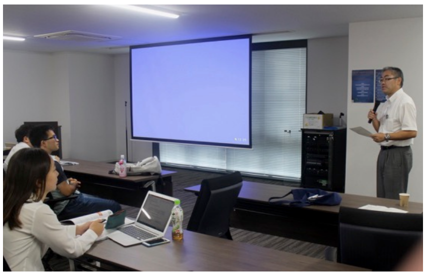



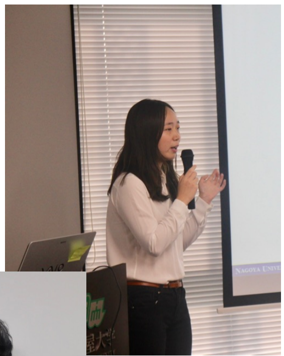
Field trip, July 14

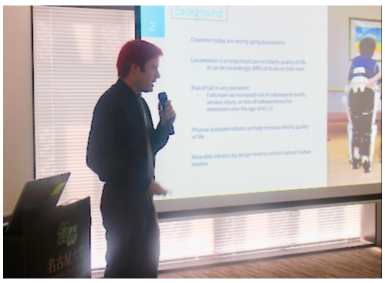
Toyota factory,
Toyota Museums and
BBQ



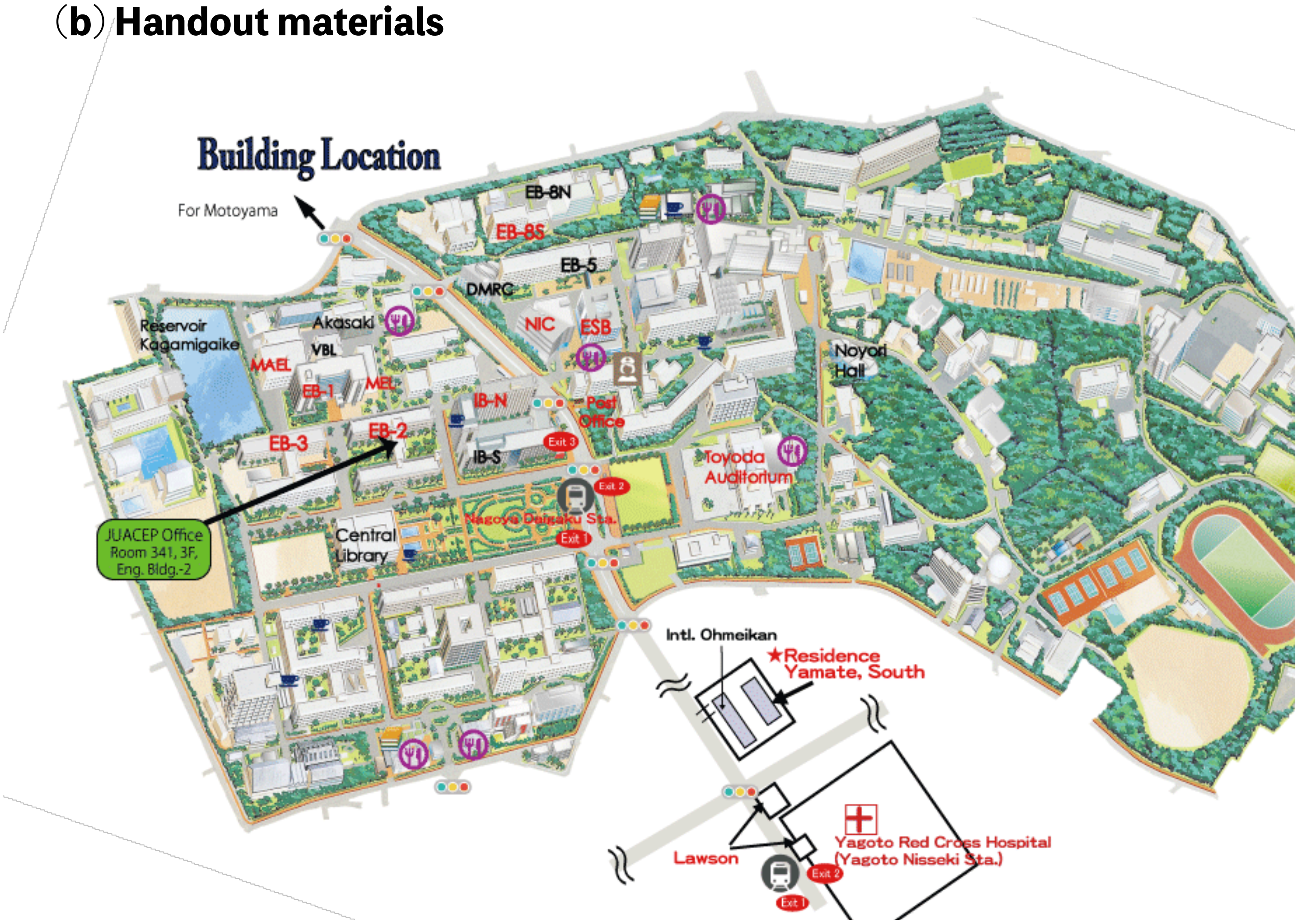
17th JUACEP Workshop, August 29







(b) Handout materials



Map Explanation

Bldg. icon on the map	Building name (in Japanese)	Important places for JUACEP	Lab locations for JUACEP students
EB–2	Engineering Building 2 (Kougakubu ni–gou–kan)	・JUACEP Office, Room 341, 3F (Tue, Thu, Fri) ・JUACEP Seminar, June 30 @Lect Room 221, 2F ・Round–table discussion, June 30 @Room 347, 3F	for Hao–En, Muzhi, Chenfan and Erik
EB–5	Engineering Building 5 (Kougakubu go–gou–kan)		for Zhiwei and Yizhen
MAEL	Mechanical & Aerospace Engineering Lab. (Kikai kouku jikkentou)		for Brian
ESB	Engineering & Science Building (E–S kan)	・Orientation of June 20 @ES Hall, 1F ・Stipend payment, July 13 & Aug 10 @ES032, 3F	
NIC	National Innovation Complex (Nic)	・20th Workshop, Aug 29 @Conference Room, 3F	
IB–S	Integrated Building South (I–B Minami–kan)		for Jia
IB–N	Integrated Building North (I–B Kita–kan)	・Japanese class @IB101, 10F ・Hands–on Execises, July 4 & 6 @Creation Plaza, 10F	
Toyoda Auditorium (Toyoda koudou)		・Meeting point for the Field Trip, July 14, 9:00am	
Post Office (Yuubinkyoku)		・Money change, Money withdrawal, Postal affairs	
	Cafeteria/Convenience Shop		
	Café		
	Book Store		
	Subway Station	Nagoya Univ.: Nagoya Daigaku Station Dormitory Yamate: Yagoto Nisseki Station	
	Health Administration Office	Open hours: 9:00–12:00, 13:00–17:00, Mon.–Fri. (052)789–3970	

Mandatory Submissions

★ All of following templates are downloadable at
http://www.juacep.engg.nagoya-u.ac.jp/downloads/index.html

1. ***JUACEP Independent research report***
   See *Appendix-1.*
   Deadline: **August 25, 2017**
   Send to… juacep-office@engg.nagoya-u.ac.jp

2. ***JUACEP Research presentation slides***
   We will collect your PowerPoint slides at the workshop site, **August 29, 2017**.

   Evaluation: your final score is calculated by the points of the research report and the presentation at the workshop evaluated by your Nagoya Supervisor;

Research report (1~50pts.) + Presentation (1~50pts.)
100~90=S, 89~80=A, 79~70=B, 69~60=C, 59~0= fail

   You will be officially awarded credits of Nagoya University and the transcript is airmailed to your home university in September 2017.

Important:

(a) JUACEP will publish the participants' research reports and the presentation slides in the website and booklet. Please ask your supervisor if it is allowed to publish to the public and let us know the result.

(b) UM students MUST transfer the credits to ME590/Engr591 and submit the transcript to JUACEP Office as soon as possible.

3. ***Findings through JUACEP***
   See *Appendix-2.*
   Deadline: **August 21, 2017**
   Send to… juacep-office@engg.nagoya-u.ac.jp
   Please write freely about your experience in Japan inserting pictures.

4. ***JASSO Scholarship obligatory questionnaires, H-2***
   See *Appendix-3. There are "Pre-arrival" part which you already submitted, and "After the program" part which you have to submit until* **August 18, 2016.**
   Send to… juacep-office@engg.nagoya-u.ac.jp

Campus Life Information

[Housing]

International Residence Yamate

Address: 165 Takamine-cho, Showa-ku, Nagoya 466-0811, Japan
Office Phone: (052) 835-5575
WiFi is available.
Please follow the residential guidelines.

[PC & ID]

Student ID Card

A student ID card is issued. It will let you into the university libraries, and with the card you may borrow books from the library. The card lets you get student discounts at museums, theatres and so on.

Use of PC on Campus See P.14 and P.15

Wireless Internet connection (NUWNET) is available on campus as far as your Nagoya University ID is effective. But at the beginning, you have to access to 'Information and Communications Headquarters' (https://ist.nagoya-u.ac.jp/) using your ID and a default password that are shown in the card delivered at the orientation, then take the online Information Security Training and pass the test. To pass the test, you must score at least 80% or repeat the test until you clear 80%. Please do all of required steps described in the web like changing passcode, otherwise acquired wireless connection will expired in a week.

University Security Department Warning

Copyright infringement using P2P software is prohibited. University has been strongly warning to all of faculty, staff and students not to use P2P software like Gntella, Share, Winny, WinMX, Xunlei, and so on. It can be easily detected and reflects discredit on University and oneself who used it.
Please never use P2P in University, nor PC in which P2P is installed accessing to University network.

[Medical & Health Care]

Medical Services

If you suffer from continuous headaches, a loss of appetite, or you cannot sleep well, etc., you should seek the advice of a doctor before the condition gets worse. These symptoms may be a sign of fatigue or exhaustion. They may also be psychological or psychosomatic symptoms, which are treatable by specialist doctors. In addition to taking care of your own health, please pay attention to your friends' health and encourage them to see a doctor, if they are feeling unwell.

(1) The Health Administration Office See Building Location map.
Students can undergo physical examinations, receive health advice, first-aid and arrange psychiatric counseling at this facility. There is no charge for using any of these services. Appointments are necessary for psychiatric counseling services. Please call the office,
Tel: (052) 789-3970

[Office Hours for Health Services]

Treatment	Time	Mon	Tue	Wed	Thu	Fri
Physical Examinations & First-Aid	10:00 - 11:30	○	○	○	○	○
	13:30 - 16:30	○	○	○	○	○
Psychiatric Counseling	10:00 - 12:00	○	○	○	○	○
	13:30 - 16:30	○	○	-	○	○

(2) Calling an Ambulance
Telephone 119 or press the RED button on a public phone for connection, free of charge. Although it is possible to speak English, it would probably be helpful for you to say the following: "**Kyuukyuusha** (ambulance) w**o onegai shimasu**. **Basho wa** "your location" **desu**."
(I am calling for an ambulance. I am at "... ".)
This number is also used for requesting fire engines (**shoubousha**).

Precautions for Food Poisoning and Infectious Diseases
Great care should be taken with regard to eating habits during the extreme summer weather in Japan. To avoid food spoilage, check the expiration date before buying food, apply heat to raw foods and be careful not to keep food in the refrigerator for an excessive amount of time. To guard against food poisoning, always wash culinary items with hot water.
Also follow the basic hygienic rules to avoid being infected.
World Health organization: http://www.who.int/en/

[Everyday Life]

Refuse Disposal at Nagoya University
A sorting system for refuse disposal is used at Nagoya University. There are trash bins for "combustible refuse", "incombustible refuse", and recycle bins for "empty bottles", "empty cans", and "PET bottles" all over campus. Papers or magazines are collected by recycle companies. Used paper products such as used copy paper are collected and recycled. Students are kindly

requested to be mindful when they throw away their rubbish and to use the correct bins to help waste reduction and the reuse of recyclable materials.
Also please follow the manners ruled in each laboratory.

Public Transportation of Nagoya City

(1) MANACA マナカ is a pre-paid IC card that can be used for subway/ city bus/ most of train companies through Japan. It is also used at convenience shops, vending machines, some restaurants, and so on.
(2) ONE-DAY TICKETS allow for unlimited rides of city traffic for a day. One-day tickets for all bus, subway, and bus & subway routes are available. Ticket, Donichi-Eco-Kippu, that can be used on Saturdays, Sundays, holidays and the 8th of every month can be also purchased. These tickets include a discounted admission fee for some tourist facilities in Nagoya city such as Nagoya Castle or the Tokugawa Museum.
They can be purchased at any subway station. For further information, refer to the website: http://www.kotsu.city.nagoya.jp/ (Japanese)
(3) Besides the city-running transportation, trains and buses of JR, Meitetsu, Kintetsu, Aonami-sen will make your passage easier.

Useful Links:
The following websites provide information on available transport services, time-tables, etc..
HYPERDIA: http://www.hyperdia.com/en/

If involved in a Traffic Accident.

If you are involved in a traffic accident, remain calm and do the following:

1. If anyone is injured, dial 119 for an ambulance.
2. Move any dangerous including vehicles, off the road to prevent other accidents.
3. Report the accident immediately, even if it is small, to a nearby police station and obtain a report of the accident.
4. Write down the license plate number of the car concerned as well as the name, address and age of the driver, after requesting to see his/her driver's license.
5. If there are witnesses, write down their names, addresses and telephone numbers.
6. Make detailed notes of the accident and take photographs, if possible.
7. See a doctor, even if you think that you are all right, because sometimes symptoms can take time to occur.
8. Consult your insurance company as soon as possible.

Compliance with Japanese Law

During their stay in Japan, any student who commits a crime, misdemeanor or any other illegal act, will be subject to legal procedures according to Japanese Law. Nagoya University also takes strict disciplinary measures against students who commit crimes or misdemeanors, and may expels them from university.

(1) Prohibition of Narcotics

In Japan, the possession and sale, for personal use or otherwise, of all narcotics and any illegal substances are strictly prohibited. If offered, refuse them. If leaving Japan temporarily, never agree to look after a stranger's luggage at the airport.

(2) Drinking and Smoking Restrictions

In Japan, people aged under 20 are not allowed to drink or smoke. Smoking is not allowed in many places, including stations, public facilities and within the campus. Nagoya city has special zones where smoking on the street is banned. If found smoking there, you will be fined.

Driving a car, riding a motorcycle or bicycle after drinking any amount of alcohol is a serious offence in Japan, and can also cause accidents. Never drive after drinking. Those who accept a ride in a car that is driven by a drunk driver or those who offer alcohol to a driver are all subject to punishment under Japanese law.

(3) Others

Whilst inside a shop, removing product wrappers, price tags or putting products into pockets or bags before actually paying for them may be treated as an attempt to shoplift in Japan. Talking loudly on your mobile phone or chatting loudly with friends in public places, such as on a train, can cause disturbance in Japan.

Safety Guide

Japan is not as safe as most people think. There is the risk of crime anywhere in the world, including Japan. Please pay attention to safety and security for yourself and your belongings in any scenes as you do in the US.

Culture Shock

Although “culture shock” is generally understood as a temporary shock felt when confronted by different cultural customs, ways of thinking and behavior patterns, it actually refers to a psychological state of depression caused by a succession of failure experiences in unfamiliar social situations. Culture shock is temporary and everybody goes through it to some extent in the process of cultural adaptation. General symptoms of culture shock include negative feelings such as: losing self confidence, feeling depressed, attributing all failure to yourself, feeling that nobody understands you, feeling inadequate, etc. Accordingly, you may lose all motivation to talk with Japanese people or to attend classes. Most of these psychological reactions are, again, very natural in the process of cultural adaptation. Please take time to cope with each single event in your life, and you will be able to overcome these emotions sooner or later.

Differences in “Academic Culture”

It is widely accepted that different values, behavioral and communication patterns exist from culture to culture. However, we often fail to realize that there are also differences in “academic culture", such as expected roles of academic advisers and students, classroom communication, evaluation criteria, etc. Such differences can also be a major cause of your stress. For example, the relationship between academic adviser and advisee is considered particularly important at the graduate level education in Japan. Some knowledge of the Japanese academic culture will help you achieve your goal more smoothly.

Cope with Stress

If you feel pressured by stress or lose confidence in your ability to study, you should think about releasing yourself from these negative emotions. Achieving good results in your studies may take a certain amount of time, and ought to be views as accumulative process. Sometimes, you will need to take a break. If you feel tired, do not push yourself too hard and try to enjoy some of your favorite foods, recreation, and physical exercise. It is also recommended that you talk with your friends, academic adviser, or international students advisors/counselors. Moreover, please do not consider the process of cultural adaptation solely as a cause of stress; you can learn tremendously about various cultures, including your own, from this process.

< Visit the office of ECIS Advising & Counseling Services>

If you feel that you cannot deal with stress or feel a sense of isolation or frustration, do not hesitate to ask for help from international counselors at the ECIS Advising & Counseling Services. There is an international student counselor who will support your personal and psychological concerns. A discussion with an international student counselor can help achieve a useful perspective on culture shock and insights into Japanese culture.

ECIS Advising & Counseling Services (7th floor, West Wing of IB Bldg.)

http://www.isa.provost.nagoya-u.ac.jp/en/

Harassment

Nagoya University has set up a Harassment Consultation Center to prevent and eliminate the occurrence of any kinds of harassment, such as sexual harassment and academic harassment. Professional counselors deal with inquiries with utmost respect for their clients' feelings and wishes. For English language consultation, you may visit the representative at the Education Center for International Students (ECIS). All consultation will be kept confidential.

Nagoya University Harassment Consultation Center (Appointments by fax or E-mail)

Tel: (052) 789-5806 (9:30-16:00)

Fax: (052) 789-5968

E-mail: sh-help@adm.nagoya-u.ac.jp

URL: http://www.sh-help.provost.nagoya-u.ac.jp/ Contact persons at each School (including ECIS)

Hospitals around Nagoya University (English available)

Nagoya Daini Red Cross Hospial (Yagoto Nisseki)

Address: 2-9 Myoken-cho, Showa-ku, Nagoya

Tel: (052) 832-1121

Mon-Fri: 8:00-11:00

Closed on Sat, Sun, holidays

Watanabe Clinic

Address: 1F Nikkou Yamate-dori Building, 3 -9-1 Yamate-dori, Showa-ku, Nagoya

Tel: (052)861-3450

Mon-Sat: 9:00-11:30

Mon, Wed-Fri: 16:00-17:30

Closed on Sun, holidays

Kai Clinic

Address: 32-2 Myoken-cho, Shouwa-ku, Nagoya

Tel: (052)836-9136

Mon-Sat: 9:00-12:00

Mon-Wed, Fri: 18:00-20:30

Closed on Sun, holidays

Yamate Dermatologist

Address: 2-9-1 Yamate-dori, Showa-ku, Nagoya

Tel: (052)836-4115

Mon, Tue, Thu-Sat: 9:30-12:30

Mon, Tue, Thu, Fri: 16:30-19:30

Sat: 14:30-17:30

Closed on Wed, Sun, holidays

Fujimi Dentist

Address: 139 Yagotohujimi, Showa-ku, Nagoya

Tel: (052)835-3200

Mon-Wed, Fri, Sat: 9:30-12:30

Mon-Wed, Fri, Sat: 14:00-19:00

Closed on Thu, Sun, holidays

Published in December 2017

Japan-US Advanced Collaborative Education Program (JUACEP)
Graduate School of Engineering
Nagoya University
Furo-cho, Chikusa-ku, Nagoya 464-8603, Japan
JUACEP@engg.nagoya-u.ac.jp
http://www.juacep.engg.nagoya-u.ac.jp