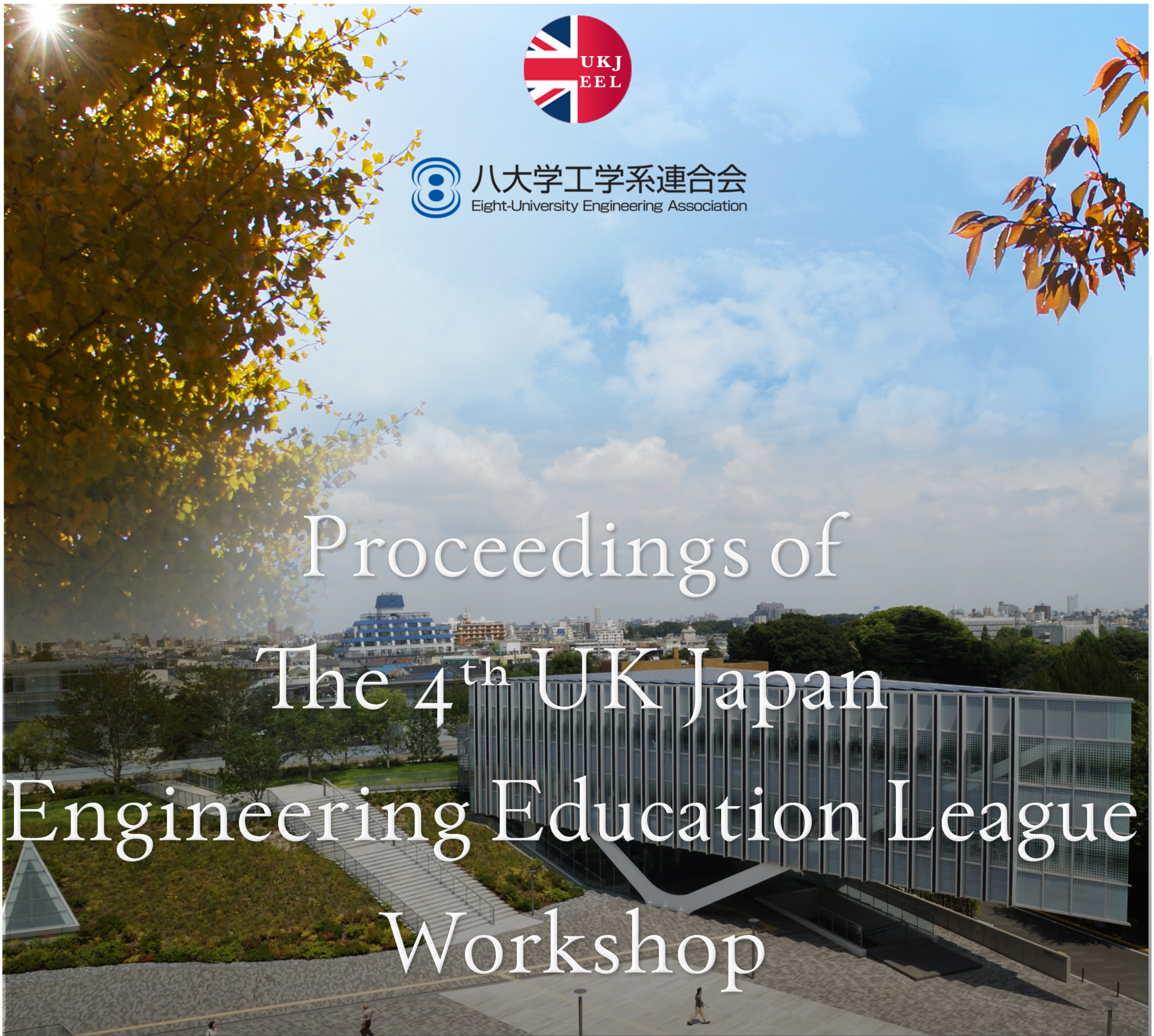

八大学工学系連合会
Eight-University Engineering Association

Proceedings of The 4th UK Japan Engineering Education League Workshop

August 5-8, 2016

Tokyo Institute of Technology
Ookayama Campus, Tokyo

Proceedings of The 4th UK - Japan Engineering Education League Workshop

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Sponsored by

Eight-University Engineering Association,
Tokyo Institute of Technology's Three Graduate Schools of Engineering,
Multidisciplinary International Student Workshop (MISW) Committee,
Human Assets Promotion Project for Innovative Education and Research (HAPPIER)

http://www.eng.titech.ac.jp/english/event/ukjworkshop4th.html

https://www.facebook.com/UKJEEL/

Welcome to The 4th UK – Japan Engineering Education League 2016

Foreword by Imperial College London Professor Roderick Smith

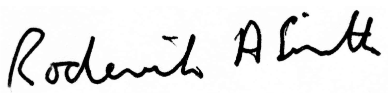
The year 2013 marked the 150th anniversary of the so-called Choshu Five starting their study at University College in London. When these young men returned to Japan, they formed the core of the Japanese Government in the Meiji Restoration period which marked the beginning of Japan's rapid development from an isolated nation to one of the world's foremost technological powers. The many events held to celebrate this anniversary led to interactions between members of leading universities in Japan and the UK, and discussions on how we might better benefit from sharing our experience of teaching and research in engineering.

These discussion led to the formation of the UK-Japan Engineering Education League at Tokyo Tech in March 2014, where it held its first symposium, followed by a second meeting at UCL in London in September 2014. The purpose of these first two meeting was for senior members of the leading engineering Universities in Japan to explore ways in which interactions might happen in order to exchange information and best practices in engineering education and to promote education through research.

These start-up activities led to a third meeting held in Oxford in September 2015 with a very specific title, Materials Under Extreme Conditions: Effects of Temperature, High Strain Rate and Irradiation. This meeting was deliberately aimed at research students who met to share their passion for research in the convivial surroundings of Pembroke College. Both the technical and social interactions between the students from both the UK and Japan were enjoyable and fruitful: we hope they will lead to lifelong professional interactions between the young students involved.

This current meeting has us returning to Tokyo Tech, again with the emphasis on research students but this time from a wide range of research areas, who will meet to describe their own research through short presentations and posters. Additionally they will explore the topic of *Mega Cities for the Future* and work in teams to develop what we hope will be futuristic and stimulating ideas. Further integration will take place on a technical tour, group working to develop ideas and, of course, during informal lunches and dinners. Meanwhile senior colleague will discuss where and how we will meet in the future.

Can I take this opportunity to thank our host on this occasion, Tokyo Tech, and to express the hope that all will enjoy the opportunities for meaningful international interactions.



Professor Roderick A Smith

Imperial College London July 2016

Welcome to The 4th UK – Japan Engineering Education League 2016

Foreword by Dean of the School of Engineering, Tokyo Tech Professor Kikuo Kishimoto

On behalf of the three Graduate Schools of Engineering at the Tokyo Institute of Technology and the workshop co-chairman, I would like to extend a warm welcome to all workshop participants.

This is the fourth meeting where faculty/students from British and Japanese universities have convened to engage in academic discourse on research and education under the framework of the UK-Japan Engineering Education League (UKJEEL) and the second time it is taking place at Tokyo Tech. This year, the workshop is proud to host a number of students and faculty from the across the UK, Europe, and Asia.

The workshop is divided into different tracks for faculty and doctoral students. The theme of the doctoral student symposium is *Mega Cities for the Future*. As the global population continues to grow and move into urban areas, mega cities such as Tokyo and London, in particular, are the first to experience the immediate effects. To enhance research discussions between students we are also holding a joint session with the Multi-disciplinary International Student Workshop (MISW) on August 8th to discuss solutions to these pressing topics across disciplines. It is my sincerest hope that the UKJEEL will continue to both serve as a means of cross-cultural information exchange and trigger new innovations across many fields.

The faculty development program this year is organized under the Human Assets Promotion Project for Innovative Education and Research (HAPPIER). By facilitating faculty development, we expect that these connections will anchor future research and educational collaborations between our institutions under the UKJEEL banner. This continued search for solutions to pressing matters as well as "developing global human resources par excellence through pioneering research" has been at the core of Tokyo Tech's mission for the past 135 years.

Participants this year will begin by attending a reception hosted by the British Embassy in Tokyo. Throughout the workshop, students will engage in group-work, presenting their collaborative efforts and findings at the end of the session. During this year's conference, all participants will also have the opportunity to go on an excursion to the Tomioka Silk Mill World Heritage Site in Gunma. The silk mill is a historical symbol of Japan's early industrial development and was a cornerstone that led to key industries upon which Japan rapidly modernized. Students will have this unique chance to see a side of Japan outside the capital through a culturally and historically educational activity.

In addition to the student presentations and faculty development program, we are pleased to welcome Professor Roderick Smith of Imperial College London to give a keynote presentation on Global Sustainability. I would also like to extend my sincerest gratitude to the Eight-University Engineering Association for their financial contribution that has enabled this year's workshop.

My best wishes for a successful workshop,

Kikuo Kishimoto
Dean, School of Environment and Society
Dean, Graduate School of Engineering/School of Engineering

Conference Organizing Committee

Conference Chairs

Kikuo Kishimoto

Tokyo Tech Professor & School of Environment and Society/Engineering Dean

Roderick Smith

Imperial College London Professor & Past President of the Institution of Mechanical Engineers

Program Committee

Chair	Shigeki Nakagawa	Professor, Dept. of Electrical and Electronic Engineering
	Masahiro Miyauchi	Professor, Dept. of Materials Science and Engineering
	Jeffrey S. Cross	Professor, Dept. of Transdisciplinary Science and Engineering
	Akinori Nishihara	Adjunct Professor at Human Assets Promotion Project for Innovative Education and Research (HAPPIER)
	Michael Norton	Adjunct Professor, Dept. of Transdisciplinary Science and Engineering
	David B. Stewart	Adjunct Professor at Human Assets Promotion Project for Innovative Education and Research (HAPPIER)
	Kaori Iguchi	Workshop Secretariat and Staff in International Engineering Cooperation Office
	Kenta Yaegashi	Summer Intern
	Akira Yamada	Professor, Dept. of Electrical and Electronic Engineering
	Jiro Takemura	Associate Professor, Dept. of Civil and Environmental Engineering

Conference Participants

UK FACULTY

Name (First, Last)	Title/ Dept.	UNIVERSITY / COLLEGE
Alan J. Murphy	Associate Dean (Science and Engineering)	Newcastle University
Brian Falzon	Professor, School of Mechanical and Aerospace Engineering	Queen's University of Belfast
Wen Wang	Professor, School of Engineering and Materials Science	Queen Mary University
Fauzan Adziman	Lecturer, Department of Engineering Science	University of Oxford
Roderick Smith	Professor, Mechanical Engineering	Imperial College London

JAPAN FACULTY

Name (First, Last)	Title/ Dept.	UNIVERSITY
Xinuzhu Gu	Assistant Prof., Dept. of Industrial Engineering and Economics	Tokyo Tech
Azril Haniz	Lecturer, Dept. of Trandisciplinary Science and Engineering	Tokyo Tech
Yuki Minamoto	Assistant Prof., Dept. of Mechano-Aerospace Engineering	Tokyo Tech
Tatsuya Ibuki	Assistant Prof., Dept. of Systems & Control Engineering	Tokyo Tech
Tetsuo Kodera	Associate Prof., Dept. of Electrical & Electronic Engineering	Tokyo Tech
Masao Yamagishi	Assistant Prof., Dept. of Information & Communications Engineering	Tokyo Tech
Michito Yoshizawa	Associate Prof., Dept. of Environmental Chemistry Engineering	Tokyo Tech
Hiroshi Tamura	Assistant Prof., Dept. of Civil & Environmental Engineering	Tokyo Tech
James Cannon	Associate Prof., Faculty of Engineering	Kyushu University
Daisuke Sano	Assistant Prof., Division of Environmental Engineering	Hokkaido University
Taro Uematsu	Assistant Prof., Division of Applied Chemistry	Osaka University
Norihiko Nishizawa	Professor, Dept. of Quantum Engineering	Nagoya University
Yoshiko Miura	Professor, Dept. of Chemical Engineering	Kyushu University
Yuzuru Sato	Project Professor, Course of Metallurgy	Tohoku University
Stephane Yu Matsushita	Assistant Prof., Dept. of Physics	Tohoku University

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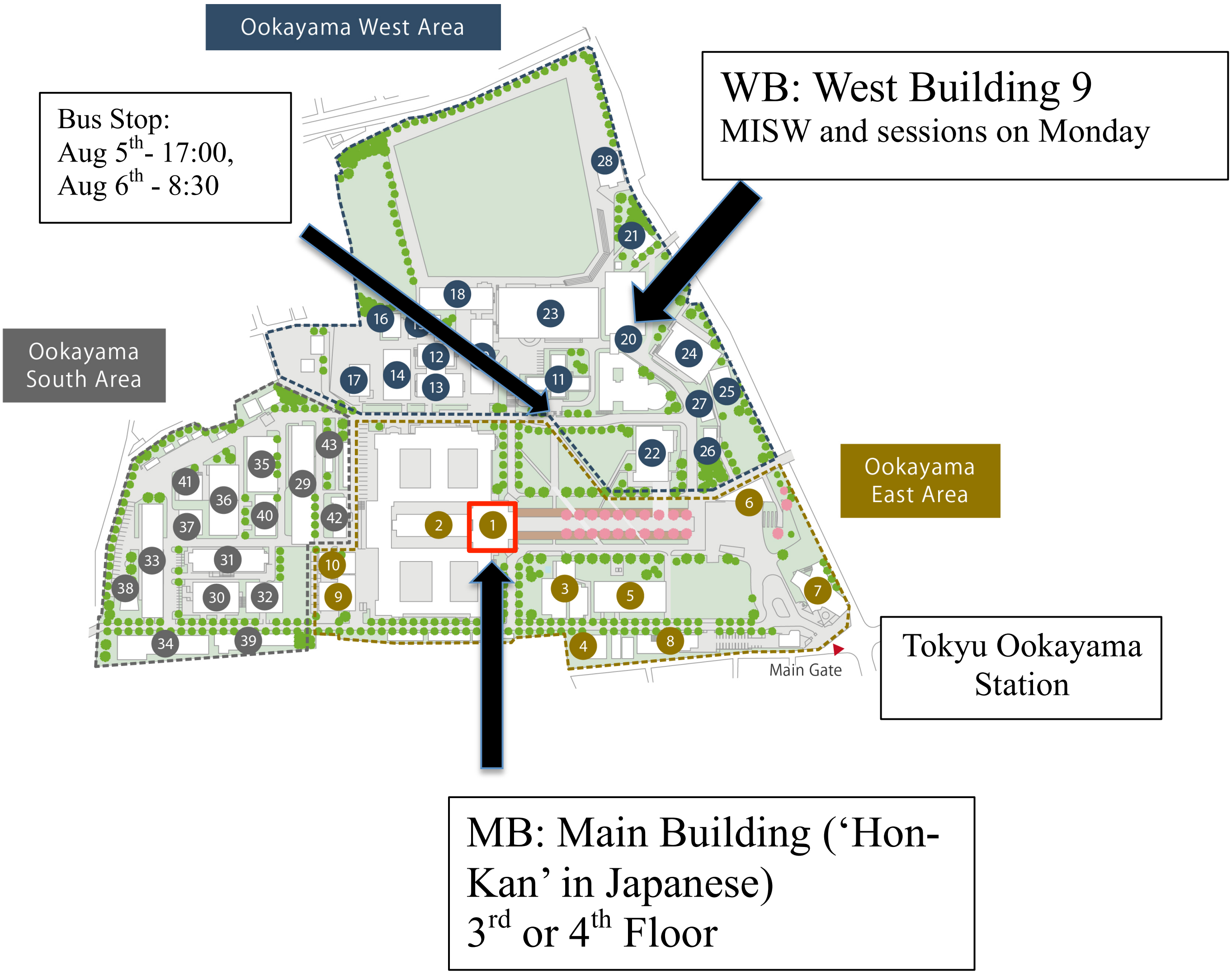
Tokyo Institute of Technology Campus Map



Schedule

Students
Faculty
Joint

5th Aug. (Fri.)

	Rm.345 (3F@Main Bldg)	Rm.410 (4F@Main Bldg)
8:30	Meetup @Shinagawa Pr.Hotel travel to Tokyo Tech	
	with Prof. R. Smith	
9:00		
9:30	Registration	
10:00	Opening Session (chairs K. Kishimoto & R. Smith)	Poster Set-up (TAs)
10:30		
	Group Photo. Location TBD	
11:00	Student Shotgun (3min) Presentation	
11:30		
12:00	Lunch Bento lunch (lunchbox)	
12:30		Student Poster Session 12:30-14:25
13:00		
13:30		
14:00		
14:25		
14:30	Faculty Round-Table Moderator: Prof. J. Takemura	Doctoral Students group work 14:30-16:50 Theme: Sustainability for Mega-cities (London and Tokyo) Prof. M.Norton
15:00		
15:30		
16:00		
16:30		
16:50		
17:00	Depart by Bus to British Embassy Tokyo	
18:00	Reception at the British Embassy (ID required)	
19:30		

6th Aug. (Sat.)

	Bus Excursion
8:30	Depart from Tokyo Tech
9:00	w/ English-speaking Tour Guide
9:30	
10:00	
10:30	
11:00	
11:30	Tour to: Tomioka Silk Mill, World Heritage Site in Gumma
12:00	
12:30	Lunch Provided
13:00	
13:30	
14:00	
14:30	
15:00	
15:30	
16:00	
16:30	
17:00	
17:30	Return to Shinagawa Prince Hotel
18:00	

7th Aug. (Sun.)

Faculty Free
Students Groupwork based activities

note:ID required for admission to British Embassy

Schedule continued

8th Aug. (Mon)

UK-Japan & MISW joint session

MISW homepage: www.aotule.eng.titech.ac.jp/MISW/2016/

Time	Digital Multi-Purpose Hall (W9- Bldg)	Collaboration Room, (W9 Bldg.)
8:30	**MISW Registration**	
9:00	**Opening Remark**	
	Photo-session	
9:30	**Break**	
	Short Presentation	
10:10		**Poster Presentation 10:10-11:10**
10:30		
11:10		
	Break	
11:20	**UK-Japan Lecture Prof. Roderick Smith**	
12:00		

UK-Japan sessions

Time	Rm.345 (3F@Main Bldg)	Rm.410 (4F@Main Bldg)
12:10	Lunch	
	Faculty Lunch (UKJEEL Business Meeting) Chair: K Kishimoto, JS Cross	Student Group Work Lunch
13:30		Student-Faculty Round-Table Moderator: J Takemura
14:00		
14:30		
15:00	Student Group work Presentation (10 min. each)	
15:30		
16:00		
16:30	Wrap-up session (chair: JS Cross)	
17:00		
17:30		
17:45		**Reception @Rm.410 (4F@MB)**
19:30		

UKJ-Workshop 2016 Students Excursion

Journey table

京王観光
KEIO TRAVEL AGENCY
2-3-10, Shinjuku, Shinjuku-ku, Tokyo
Shinjuku Gyoen building 2F
TEL 03-5919-4831
FAX 03-3359-2570
Azusa Hirano

Destination	Date	Persons
GUNMA	2016/8/6 Sat. ～ 2016/8/6 Sat.	30

	Date	Schedule			
A	2016/8/6 Sat.	**08:30** Tokyo Tech ====== (highway) ====== 11:00～12:30 Tomioka Silk Mill =========	By Bus		
		13:00～14:00 === Lunch time ("KAMAMESHI" at Ogino-ya) === 14:15～14:45 Michi no eki KANRA (Japanese style Roadside station)			
		16:00～17:00 === (highway) ====== KAWAGOE (A town with the traditional feel of Edo Tokyo) =========			
		18:00 === (highway) ====== Shinagawa Prince Hotel			

Tomioka Silk Mill is a model mechanized silk-reeling factory established by the Meiji government in 1872 (5th year of Meiji) for the modernization of Japan.
After the Meiji Restoration, the government pushed forward the modernization of industry and sciences in order to put Japan in a position of equality with foreign countries. The industry in which the governement put the most effort to gather the founds necessary for this task was raw silk export. The government decided to establish a national model factory equipped with Western silk-reeling machines in order to improve raw silk quality, to raise production and train technical supervisors.
This is how Tomioka Silk Mill was built and it remains today in an almost perfect condition.

【KAMAMESHI】
rice, meat and vegetable dish served in a small pot.
This is the feature of Gunma-ken.

【KAWAGOE】
Kawagoe has many superb sights. For example;
* The Kitain Temple with a beautiful Japanese waterless garden.
* The Kurazukuri daubed houses, very Kawagoe-like 100% fireproof buildings which remain, not as remains of the past, but as the actual working places of modern-day people.
*The Time Bell Tower; the alley lined with shops selling cheap sweets;

Student Group Work

<u>SESSION ON SUSTAINABILITY FOR MEGACITIES (Doctoral students work group)</u>

Session Chair: Tokyo Tech, Dr. Mike Norton (norton.m.aa@m.titech.ac.jp)

5 August (Fri) 14:30- 16:50, Main Bldg. 4th Floor, Introduction and Workshop guidance

16:50 End Group work

Background Brief

Megacities--metropolitan areas with populations greater than 10 million--continue to grow. In 1970, there were only eight megacities; by 2010 they had grown to 27 and are expected to reach 37 by 2020. For data on how resources pass through them- see Kennedy, C. et al., 2015. **Energy and material flows of megacities**. *PNAS*, 2015 DOI: 10.1073/pnas.1504315112

Today's megacities house 6.7% of the world's population, consume 9.3% of global electricity and produce 12.6% of global waste. Some points from Kennedy et al (see Figs. A,B,C):

- New York has 12 million fewer people than Tokyo, yet it uses more energy.
- Tokyo's extensive and efficient public transit reduces its environmental impact. Tokyo`s water are 3% (compared with >50% in Rio de Janiero and Sao Paolo).
- Moscow has a district heating system to buildings housing 12 million people
- Seoul reclaims wastewater for secondary uses like flushing toilets.
- London has rising electricity costs and taxes on disposal of solid waste and is the only megacity for which per capita electricity use is falling.

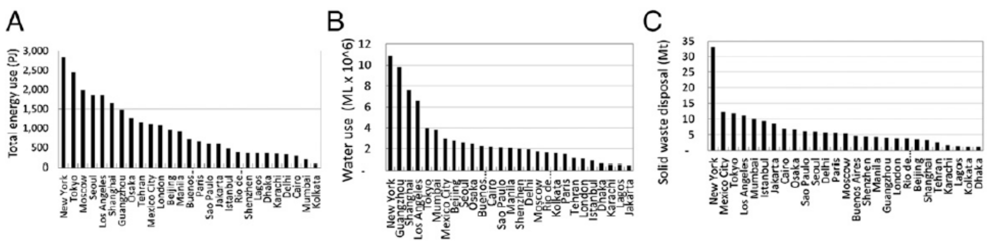


Fig. 1. Resource flows for megacities in 2011. (*A*) Energy use. (*B*) Water use including line losses. (*C*) Municipal solid waste production. Values shown are for the megacity populations scaled on a per capita basis from recorded data for the study area population (*Methods*).

In addition many megacities are increasingly concerned with **resilience** against natural disasters (earthquakes, tsunamis) and human-originating threats, including sea-level rise and associated storm surges.

Workshop – each group will be assigned a topic as noted below based upon answering the question below

Concerning sustainability indicators of energy and resources consumption, and production of wastes (gas, liquid and solid), what factors would you prioritize to improve the sustainability of London and Tokyo megacities?

1. Please address energy generation, efficiency and usage.

2. Please address transportation issues

3. Please address food, waste and recycling

4. Please address employment and quality of life issues

5. Please address housing and infrastructure issues

6. Please address resilience issues (for Tokyo earthquakes and tsunami). For both cities sea-level rise and storm surges.

Schedule

5 August (Fri) 14:30- 16:50**,** Main Bldg 4th Floor rm. 410: Student Workshop

7 August (Sun) Groups can organize their own visits/activities related to their project

8 August (Monday) 12:10 – 13:30, Main Bldg. 4th Floor rm. 410: Student Group Work Lunch

Main Bldg. rm. 345, 15:00 – 16:30 Group presentations (10 min plus 5 min Q&A)

Revised Faculty Development Program

• TOPICS •

UNIVERSITY/ INDUSTRY TEAMING *and* FACULTY/ STUDENT MOBILITIES
(EMPHASIS ON TRANS-DISCIPLINARY RESEARCH AND TEACHING)

ROUNDTABLE DISCUSSION: Part 1

Time: Friday, 5th August 2016 14:30-16:50

Place: Main Bldg., 3rd Floor Meeting Room 345

Session Chairs: Professors Akinori NISHIHARA / Akira YAMADA (Tokyo Tech, HAPPIER)

Moderator: Associate Professor Jiro TAKEMURA (Tokyo Tech)

Session 1 Agenda:

14:30 - 14:40 Greeting from Session Chair and Introduction of HAPPIER

14:40 - 14:50 Brief Self-introduction by Each Participant

14:50 - 15:20 Presentations by Invited Speakers and Discussion:"Implementation of Cooperative Research Schemes and Examples of International Faculty Exchange"

Speakers and titles (presentation time 5-10 mins)

Dr. Mitsuhiko OI (Professor, Office of Industry Liaison (OIL), Tokyo Tech)

"*Research Collaboration at Tokyo Tech with Emphasis on Industry and Overseas Universities*"

Dr. Norihiko NISHIZAWA (Professor, Graduate School of Engineering, Nagoya University)

"My Experiences of Faculty Exchange at Osaka University and MIT"

Dr. Daisuke SANO (Associate Professor, Faculty of Engineering, Hokkaido University)

"Overseas Study and International Research Collaboration"

Dr. Nobuhiro CHIJIWA (Associate Professor, School of Environment and Society, Tokyo Tech)

"*My Teaching Experience in SIIT, Thammasat University, Thailand*"

15:20 - 15:40 Discussion

15:40 - 15:50 Short Break for Coffee/ Iced Coffee / Water

Session 2 Agenda:

15:50 -16:10 Presentations by Invited Speakers and Discussion: "Promoting Global Engineering Competencies via Faculty Mobility and Student Innovative Learning"

Speakers and titles:

Dr. Masahiro SUSA (Professor, School of Materials and Engineering)

Dr. Eri OTA (Professor, Center for International Education, Tokyo Tech)

"Tokyo Tech's Promotion of International Education through Our Global Scientists and Engineers Course"

Hideki MORI, MSc. (Associate Professor, Center for Innovative Teaching and Learning, Tokyo Tech)

"Learning through Designing"

16:10 - 16:45	Open Discussion: Table and Floor
16:45 - 16:50	Preview of Monday, August 8th, Session
16:50 (***Strict***)	**Adjournment** and ***Departure by Bus for Reception at the British Embassy***

ROUNDTABLE DISCUSSION: Part 2

Time: Monday, 8th August 2016 13:30-14:50

Participants: Students and Faculty

Place: Main Bldg., 3rd Floor Meeting Room 345

Session Chairs: Professors Akinori NISHIHARA/ David STEWART (Tokyo Tech, HAPPIER)

Moderator: Associate Professor Jiro TAKEMURA (Tokyo Tech)

Agenda

13:30 - 13:40	Brief Review of Friday Sessions by Session Chairs And Moderator
13:40– 14:40	Presentation and Discussions by Invited Speakers: "Looking Forward: 2017 and Beyond"

Speakers and titles

Dr. Roderick SMITH (Professor, Dept. Mechanical Engineering, ICL)

"Industry Related Research and International Exchanges at Imperial College London"

Dr. Fauzan ADZIMAN (Lecturer, Dept. Engineering Science, University of Oxford)

"*Industry/ University Cooperation • Faculty/ Student Exchanges as Viewed from Oxford*"

Dr. James CANNON (Associate Professor, School of Engineering, Kyushu University)

"*Sustainable Global Education • International Cooperation in Joint Industry / University Research and Education*"

Dr. Yoshiko MIURA (Professor, School of Engineering, Kyushu University)

"*How to Create a Career Path* "

Dr. Jeffrey S. CROSS (Professor, School of Environment and Society, Tokyo Tech)

"*Tokyo Tech's Engineering International Research Exchanges and Summer Programs*"

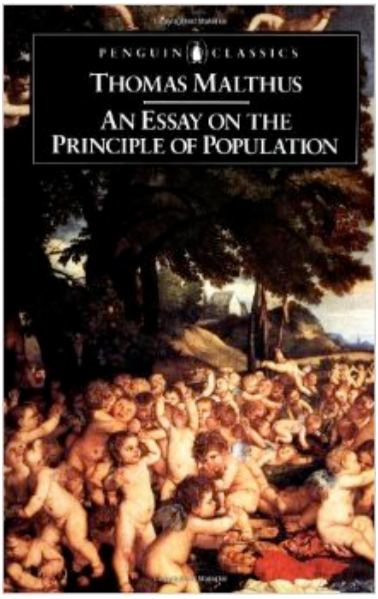
- Open Discussion including comments from students (**time permitting**

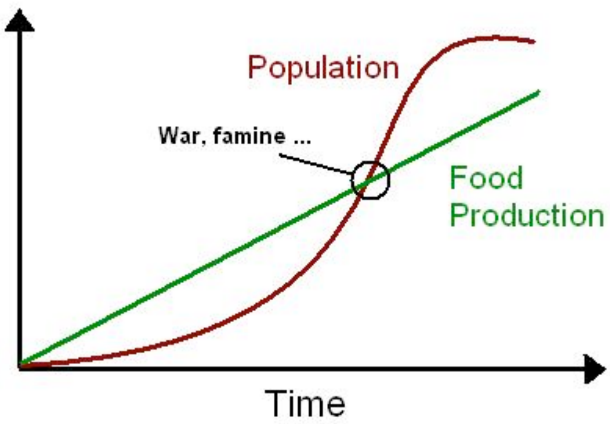
Keynote Lecture

Global Sustainability: Do I hear echoes of Malthus?

R A Smith
Mechanical Engineering, Imperial College Lodon, UK
e-mail: roderick.smith@imperial.ac.uk

Thomas Malthus was a eighteenth century British clergyman who is remembered for this book, *Essay on the Principle of Population* . He postulated that the rise in population was geometric, whilst the increase in food production was linear, and eventually when the population exceeded the food supply, there would be famine, starvation and conflict which would dramatically reduce the population. In the jargon we are now so fond of, we call this *a hard landing*.





But this Malthusian apocalypse has been avoided for many decades, essentially by a huge migration of people from Western Europe to America and a rise in mechanisation and technology which allowed agriculture to become much more efficient. We have come to accept that economies can grow continuously, that population can grow and that wealth will increase. But if we consider the history of conflict, such as the colonisation of countries by European states, the geopolitics of oil in the Middle East, the reasons behind the Pacific war, we see that they are essentially driven by the simple idea, "I need it, you have it, I will take it from you". In a broad sense this is a characteristic of capitalism (but we note that capitalism as virtues as well). I speak now from a divided Europe, troubled by housing refugees from conflict, and by ideas of rising xenophobia, protectionism and fear. The world has billions of people living very comfortable lives and billions more living in abject poverty. We should ask ourselves, is this a comfortable situation, indeed, is it morally right that we allow this to continue?

We now acknowledge that we are harming our future because of our production of CO_2 and its effects on climate. Often overlooked in this debate is the fact that resources are being depleted at a rate faster than their replacement. If everyone on earth lived in the stye of the developed nations, we would already need the resources of three planets. So the vital questions that face us are, how many people can the earth sustain, and at what standard of living and how can we move to a sustainable position without conflict?

You may think that these issues are not the business of engineers and scientist. But they most definitely are. We need to properly understand these challenges to society, because, to a large extent, the success of technology has caused them and, certainly, technology has a vital role in solving them.

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Malthus, T. R. 1798. An Essay on the Principle of Population (Many subsequent reprints)

Abstracts Table of Contents

Abstracts of
The 4th UK - Japan
Engineering Education League
Workshop

Secondary Alpha in Ti-6Al-2Sn-4Zr-6Mo

A. K. Ackerman* and D. Dye *

*Department of Materials, Imperial College, Exhibition Road, London SW7 2AZ
e-mail: aa514@ic.ac.uk

I. INTRODUCTION

In recent years, increased use of aviation in the private and public sectors has fuelled research into improving existing alloys in gas turbine engines. Currently about 20% of all UK CO_2 emissions are from gas turbine engines, with 5% coming from aviation, so improving their efficiency in terms of fuel consumption and emissions is incredibly important for long term sustainability. There is a predicted rise of 4.7% [1].

A gas turbine engine works on four primary principles: suck, squeeze, bang and blow. The fan at the front of the engine sucks in large amounts of air, which is then squeezed by the compressor. This compressed air is the ignited in the combustion section of the engine and blown out of the rear of the engine through a turbine, which drives the compressor. These sections are connected together by shafts.

II. THE IMPORTANCE OF MICROSTRUCTURE

This work is focused on improving the microstructure in Ti-6Al-2Sn-4Zr-6Mo, which is currently used in the high pressure compressor. The material has an intricate microstructure resulting from complex thermo-mechanical processing, comprising of large primary and smaller secondary alpha plates surrounded by a beta matrix (Figure 1).

Alpha and beta phases refer to the atomic structure that the material is made of. Alpha is a hexagonal close packed (HCP) arrangement, and beta is a body centered cubic (BCC) arrangement [2]. The way these two phases form and interact scales up to affect the macro properties of not just the material, but also the component that it forms. The presence of secondary alpha gives significant strength benefit to the alloy, but the details of the controlling factors such as size, spacing and orientation are not fully understood. The main aim of this project is to understand microstructure formation in this alloy, so that improved microstructure control through processing can be achieved.

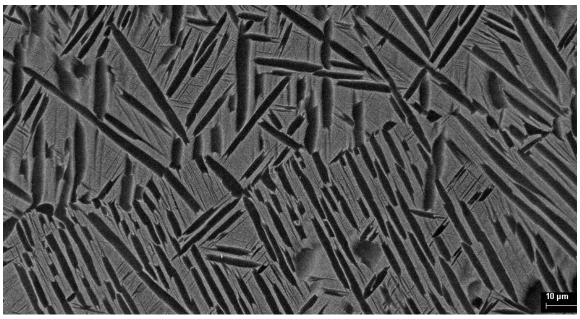

Figure 1. Ti-6Al-2Sn-4Zr-6Mo in the as received condition

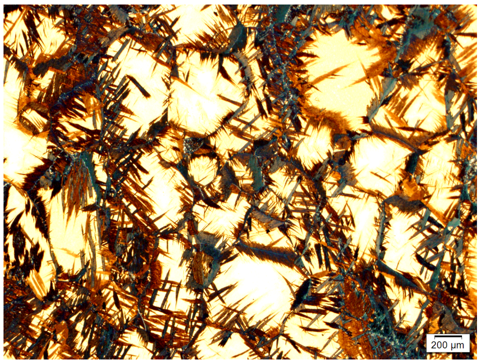

Figure 2. Tracking primary alpha velocity in Ti6246. Samle has been heated at 960°C, cooled at 10°Cmin^{-1} to 800°C and water quenched

Secondary alpha forms upon cooling, but the resulting microstructure can vary significantly depending on the exact conditions, of particular interest in this work are cooling rates and quenching temperatures. By using an Electrothermal Mechanical Testing System (ETMT) the velocity of primary plate growth can be measured and predicted (Figure 2). This is done by rapidly changing temperature from above the beta transus to the alpha beta region, then quenching to a variety of temperatures, followed by detailed microstructural characterisation using optical microscopy (OM), scanning electron microscopy (SEM) and transmission electron microscopy (TEM). Additionally, the Ivantsov solution is used to computationally predict plate growth to compliment this work [3].

III. CONCLUSIONS

In its lifetime, a gas turbine engine will go through many cycles, putting a large amount of pressure on its components. Properties such as strength and Low Cycle Fatigue (LCF), can cause early failure, and have a negative impact on the engines fuel consumption. By improving microstructure through this work, the material and the component can be improved to extend its lifetime and allow for better efficiency in the engine by saving weight and therefore decreasing fuel comsumption.

REFERENCES

[1] Department for Transport, *UK Aviation Forecasts,* January 2013

[2] G. L□utjering, J. C. Williams *Titanium*. second ed., Springer, New York, 2003.

[3] R. Trivedi, *Metall Trans.* 1, 921 (1970)

Avoiding Local Trap in Nonlinear Acoustic Echo Cancellation using Hard-Clipping

H. Kuroda*, M. Yamagishi* and I. Yamada*

*Dept. of Information and Communications Engineering, Tokyo Institute of Technology, Japan

e-mail: kuroda@sp.ce.titech.ac.jp

Nonlinear acoustic echo cancellation (NLAEC) aiming to attenuate the nonlinear echo signal has become increasingly important because, e.g., today's telecommunication devices often include small amplifiers and loudspeakers introducing significant saturation nonlinearity [1–8]. The overall echo path is the cascade of the amplifier and the loudspeaker followed by the room propagation. The former ones and the latter one can be modeled by the hard-clipping and the finite impulse response (FIR) system, respectively [1–5]. A major goal of the NLAEC is to learn adaptively the threshold of the hard-clipping and the impulse response vector of the FIR system [1–5].

The conventional learning algorithms [1–5] are extension of the NLMS [9] and derived by a gradient descent method applied to the squared estimation residual. Dependency only on local information, i.e., the gradient, causes a major drawback, to which we refer as local minima trapping, that the threshold is never updated if its current estimate is larger than the amplitude of the input signal [2–4].

In this paper, we solve the local minima trapping by exploiting, as global information on the desired threshold, a feasible threshold set consisting of all thresholds satisfying that the estimation residual is less than a given constant. To use the set in the estimation of the hard-clipping, we provide its explicit representation as a union of closed intervals by using the piecewise linearity of the estimation residual. The proposed adaptive learning algorithm for the hard-clipping is derived by tracking the convex hull of the set based on the Projection Onto Convex Sets (POCS) [10–13]. Moreover, we present an efficient computation for these procedures, which has comparable computational complexity to the conventional algorithms. In the adaptive learning of the FIR system, we propose to use the Huber loss function [14] for the robustness against the error in the estimation of the hard-clipping in the initial stage. Numerical examples show that the proposed adaptive learning of the hard-clipping is free from the local minima trapping, and the proposed simultaneous learning has the best steady-state behavior in the echo return loss enhancement.

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Effect of grain boundary serration on creep property of Nickel-based Superalloys

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I. Introduction

Nickel based superalloys are primarily used under extreme operating conditions, such as in jet engines for aerospace applications, industrial gas turbines for power generation and nuclear reactors. Their development holds significant importance from critical aspects of both economics and environment for cleaner energy and thermal efficiency. Mechanical properties of the high temperature material are highly dependent on its microstructure, which can be altered correspondingly with different processing routes. By understanding the relationship between microstructure and its properties, it is possible to design materials with specific mechanical properties using desired methods. For widely used polycrystalline Nickel alloys, grain boundary engineering has been employed for improving creep and fatigue properties, which are considered as the most critical limiting properties. This includes serration in grain boundaries via heat treatment that has shown promising enhancement in various alloy systems [1,2]. However, the formation mechanism of serrated grain boundary is not clear and improvement on properties are still empirical, hence, we propose to resolve the problem by a systematic study on a number of representative nickel alloys. The overarching objective is to gain a better understanding in designing alloys that helps in evaluating safety regulations.

II. Methodology

For generation of serrated grain boundaries, heat treatment that slowly cooled from solution temperature to an intermediate temperature will be employed with various cooling rates and holding time. The final grain size and distribution will be predicted using explicit microstructure modelling and compared with experiments. Creep tests will be performed at high temperatures on specimens with comparable grain size but different grain boundary morphologies (flat and serrated). EBSD and FEG-SEM will be used for characterisation and analysis.

III. Results and discussion

It has been shown that generation of different grain boundary morphologies is possible with heat treatment in both solid solution and precipitate hardened nickel alloys. Serration in grain boundaries are all observed associating with grain boundary phases, such as carbides and gamma primes. The formation of grain boundary serration (GBS) relates to crystallography and nucleation events of 2^{nd} phase particles, as their preferred nucleation sites are grain boundaries when nucleation driving force is low and coherent nature of these phases "twist" grain boundary to be serrated. Creep tests of IN600 samples with GBS/None-GBS (NGBS) are shown in Figure 1. It shows discrepancy on minimum creep rate and rupture strain. With introduction of GBS, rupture strain is enhanced, however minimum creep rate has been raised as a trade off. Microstructural analysis shows that cavitation frequency in ruptured sample with GBS is much higher than without GBS, which implies crack propagation is inhibited by discontinuous crack path, and hence, improved intergranular crack resistance. However, with introduction of GBS by slow cooling from solution temperature, the size and distribution of 2^{nd} phase particles in grain interior is diluted, as a consequence of decreasing intragranular crack propagation, which traded off minimum creep rate.

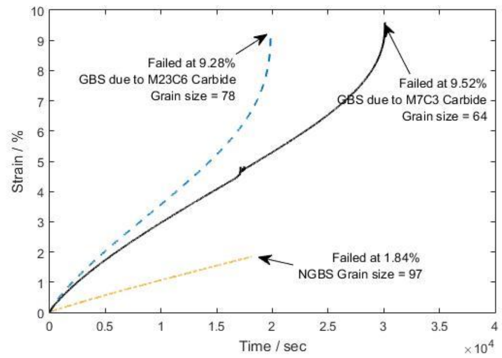

Figure 1. Creep curves of In600 specimens heat treated differently that obtained None-GBS or GBS which are induced by M_7C_3 or $M_{23}C_6$ carbides. (grain sizes are measured in micrometers)

IV. Conclusions

Heat treatment has shown possibility of changing grain boundary morphologies in nickel alloys; creep properties can be altered correspondingly. Creep ductility can be enhanced due to GBS by trading off the minimum creep rate. By understanding the condition of a particular application, it is possible to seek an optimum solution to fulfil both needs in creep rate and ductility.

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Designing low-emission aero-engines using adjoint methods

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As demand for air transport increases, the need to enhance the aircraft performance and reduce emissions also increases. One route to aircraft engine performance improvement, investigated in this work, is to use the parameters defining features in the CAD model geometry (Fig. 1) as the design variables in the optimization loop. One advantage is that it eliminates the need to recontruct the design model for the purpose of optimization, allowing a more efficient and integrated optimization process. Another advantage of using the feature based model is that the optimized model produced can be directly used for the downstream applications, including manufacturing and process planning.

Adjoint methods have been the subject of considerable research in recent years [1], and can be used to compute the gradient of a large number of design variables at minimal cost. The goal of this work is to present an efficient CAD-based adjoint process chain for calculating parametric sensitivities (derivatives of the objective function with respect to the CAD parameters) in timescales acceptable for industrial design processes. This approach differs from other methods due to the fact that it works with existing commercial CAD packages (unlike most analytical approaches) and it can cope with the changes in CAD model topology and face labeling which hamper similar approaches [2].

The approach is demonstrated on a Nozzle Guide Vane (NGV) of a high pressure turbine (HPT) provided by Rolls-Royce, which governs the engine mass flow (and by association the capacity) and defines the narrowest cross section of the turbine. Optimizing this can significantly reduce the amount of energy required to provide a certain performance.

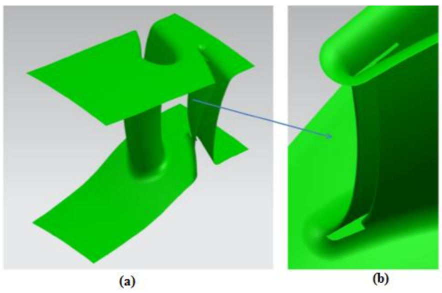

Figure 1 3D parametric CAD model in Siemens NX: a) NGV geometry and b) TE cooling slot

In order to capture the CAD surface movement with respect to the change in parameter value (Δp), the Parametric Design Velocity (V_n) is calculated, which is the movement of the CAD model boundary in the normal direction due to a change in parameter value. The approach herein is a significant enhancement on [3] in terms of the functionality provided, and can be easily integrated into most industrial optimisation workflows. The implementation calculates the design velocity in the normal direction based on projections between discrete representations of the original and perturbed geometry. Parametric design velocities can then be directly linked with adjoint surface sensitivities (ϕ) to extract the gradients ($\Delta J/\Delta p$) needed in a gradient-based optimization algorithm, where

$$\Delta J = -\int \phi V_n dA \qquad (1)$$

A 3D parametric CAD model of a NGV was built in Siemens NX, defined using geometric parameters, as shown in Fig. 2, and capacity is considered as the objective function.

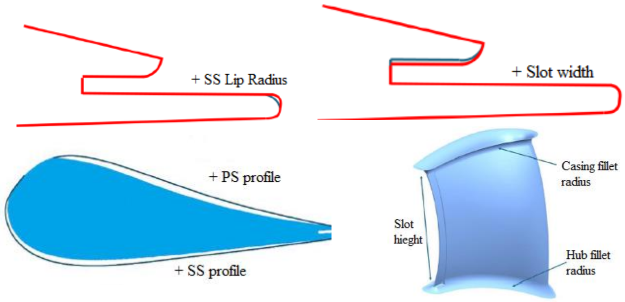

Figure 2 CAD parameters considered as design variables (not to scale)

The change in capacity (improvement in performance) caused by each parametric perturbation is predicted by taking the inner product of the sensitivity map with the corresponding design velocity field fo the parameter. The obtained derivatives are shown in Fig. 3, where they are compared with central Finite Difference values showing good correspondence.

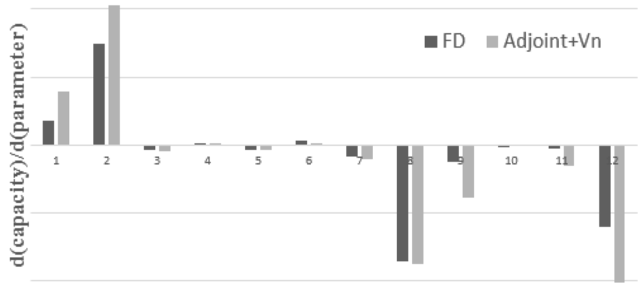

Figure 3 Capacity derivatives predicted by adjoint results and validation against FD

The computational cost to perform one flow analysis takes nearly one day, thus doing a finite difference study would for for the NGV test case (12 design variables) would result in 3 weeks of time, whereas the proposed approach takes only two days (1 CFD + 1 adjoint). The computation of design velocities is done in parallel to the flow analysis and takes only 45 minutes.

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Development of transparent cellulose film using CO_2 switchable system

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I. Introduction

It is a challenge to develop transparent film from unused materials and renewable sources. About 0.5 million ton [1] of cassava pulp waste is generated from cassava starch industries in Thailand every year. Cellulose, natural polymer is the main part of these waste. Recent year cellulose gains numerous attentions in many fields because of biodegradable, renewable and low cost properties. However the strength attachment between cellulose chains from hydrogen bonds makes it is insoluble in almost organic solvents and difficult to process to generate new products.

Carbon dioxide has ability to switch the solvent properties such as polarity and hydrophilicity changes. 1,8-Diazabicyclo [5.4.0]undec-7-ene (DBU) is a low polarity organic compound have been described to react with CO_2 which change it into high polarity. These system is called switchable polarity solvent (SPS).

In this research SPS was engaged to dissolve cellulose for transparent cellulose film production. Carbon dioxide pressure effect was investigated at constant temperature. The properties of the final modified cellulose film were analyzed using FTIR and TG analysis.

II. Methods

A. Dissolution of cellulose powder in SPS

Cellulose powder 4%w/v was dispersed in a solvent that contains DBU/EG (1:2 mole ratio) and DMSO in a glass cell. The glass cell was transferred to high pressure vessel and then CO_2 gas was introduced into the vessel. The pressures of CO_2 were chosen as 0.1, 5, 8 and 10 MPa whereas the temperature was fixed at 40˚C for 2 hrs with stirring. The mixture was then heated for CO_2 desorption and finally the cellulose solution was obtained.

B. Casting

The cellulose solution was then casted on a glass slide and coagulated into ethanol. After serveral times washing with ethanol and drying, the transparent film was collected.

III. Results and discussion

A. Film appearance

Figure 1 shows the mixtures and fabricated films appearance that reveal at 5 MPa the mixture shows clearer and the film shows more transparent than the others while at 8 and 10 MPa the mixtures were precipitated.

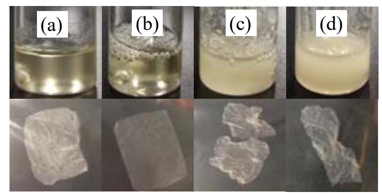

Figure 1. The mixture after treatment and fabricated film appearance at 0.1 MPa (a), 5 MPa (b), 8 MPa (c) and 10 MPa (d) of CO_2 pressure.

B. Fourier transform spectroscopy

FTIR result in Figure 2 shows asymmetric and symmetric carbonyl stretching bands around 1668 and 1422 cm^{-1} and also shows asymmetric C-O-C stretching vibration of carbonate compound around 1261 cm^{-1}. While protonated $C=NH^+$ and N-O stretching vibration of DBU salt are shown around 1617 and 1241 cm^{-1} [2,3].

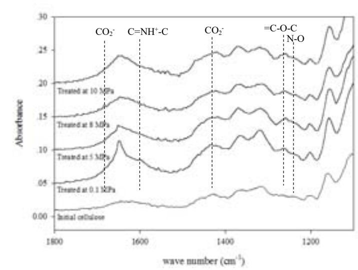

Figure 2. FTIR spectra (1800-1100 cm^{-1}) of initial cellulose and fabricated cellulose film at different pressure of CO_2.

C. Thermogravimetric analysis

Oxidative decomposition temperature (Td) of cellulose films were masured from TG curve and the results show a correlatively decrease in Td of fabricated film with pressure at 0.1 and 5 MPa. Nevertheless, at 8 and 10 MPa are an exception, Td of fabricated film is close to initial cellulose.

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A Socio-technical Study of Electric Automobility in London and Hong Kong

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INTRODUCTION

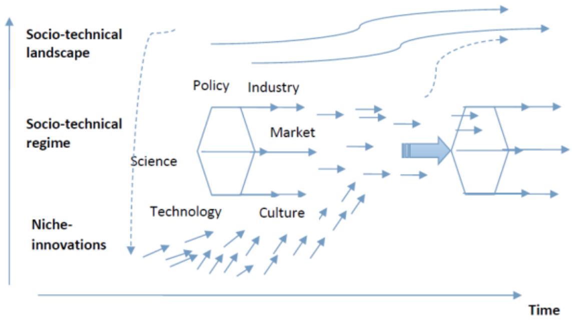
A low-carbon EV transport ecosystem in a broad sense is the combination of people, facilities and environment – including users& industrial practitioner, EVs & infrastructures, policies & incentives, technology innovation and environmental impacts. No single element can be isolated and decoupled from others in the system. This research work will focus on exploring the three key elements in electric transport ecosystem and the social-technical transition in mega cities including London and Hong Kong. The ultimate goal is to quantify the environmental & economic benefits of introducing EV, to promote EVs to extended group of users by planning prospective facilities and taking soft & hard measures for a sustainable electric automobility transport system.

METHODOLOGY

Firstly, a qualitative analysis will be employed by conducting semi-structured interviews with EV users, industrial practitioners and policy makers to investigate their experience& feedback of using an EV as well as the policy trend in the two cities. Besides, a Life Cycle Analysis (LCA), will be conducted to calculate the Greenhouse gas (GHG) balance, energy efficiency and cost-effectiveness, from the cradle to grave of EVs armed with different battery and motor configurations. The LCA perspectives of input and output will be examined by building a systematic life cycle analysis model for EV manufacturing, operation and recovery in the two urban scenarios. Lastly, the multi-level perspective (MLP) scenarios will be built for the analysis of socio-technical transition of electric automobility, as well as to investigate the relationship &interaction of EV users, policy measures & incentives and EV technology innovations as a whole.

METHODS

Considering the electric automobility transition is resulting from interaction of technology and society, a comprehensive study including qualitative and quantitative analysis will be carried out by LCA and MLP method. In the qualitative study, conversational interviews will be conducted first among selected EV users & practitioners to profile the background information of early EV adopters and collect regulatory information from policy makers & key opinion leaders in London and Hong Kong. In the quantitative LCA study, the functional units are GHG balance (gCO_2-eq/km) by the IPCC Global Warming Potential (GWP) unit, energy efficiency (MJ energy input/ MJ energy output) by Cumulative Energy Demand (CED) and cost-effectiveness ($/km) by life cycle cost analysis (LCCA) indicator. The GWP was used to calculate the GHG emissions in units of CO_2-equivalents for all GHG emissions, CED was used to calculate the ratio of energy out to energy input while LCCA refers to overall cost in dollar amount of EV use throughout the life cycle. The results will show the total GHG reduction, energy saving and cost saving for EV manufacturing and operation when compared with conventional vehicle. The MLP model features an analytical distinction among three levels. [Fig.1] The non-linear transition of EV ecosystem development could be reviewed base on the interplay of multiple developments at three analytical levels. (exogenous landscape, regimes and niches)



Multi-level perspective on transitions (adapted from [1])

EXPECTED RESULTS

The EV ecosystem of London and Hong Kong can be viewed as two different socio-technical scenarios to address the core analytical puzzle of transitions to EV ecosystem in urban area. Data collected from semi-structured interview, LCA of EV use, technological trajectories and policy measures will be analyzed under MLP framework. The link between user, environment and the technology will be well conceptualized in the framework and an integrated strategy will be proposed to electric automobility development in urban areas.

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Pyrolysis of Municipal Plastic Waste for Fuels and Chemicals

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I. Introduction

Plastics are a very convenient materials due to their versatility, low weight, high resistance, durability and low cost. Since their first used back in the 19th century, plastic products have gained popularity every year. During 2014, it was estimated that global plastics demand was 311 million tonnes of which about 40% corresponded to packaging products, 20% to building and construction and the remaining 40% to other uses such as agriculture, electric devices, automotive, etc [1]. The main fraction (48.5%) is comprised of thermoplastics (high and low density polyethylene - HDPE = 12.1% and LDPE = 17.2%- and polypropylene – PP = 19.2%-). The remaining fraction is comprise of polyvinyl chloride (PVC = 10.3%), polystyrene (PS = 7%) and other polymers (27.2%) such as polyurethane, ABS or Teflon.

II. Waste management

The increasing demand of plastic products implies a rise in plastic waste. Since 2004, plastic waste in Europe have been steadily rising about 2% p.a. [2]. Despite the promotion of re-use and recycling treatments in legislation, still half of the global plastic waste generated every year end up in landfills. The latter constitutes several serious environmental problems:

1) Plastics do not biodegrade and they accumulate for hundreds of years

2) None of the resources used during manufacture are recovered when plastics are disposed

3) Space for landfill sites is limited and even when they are well-managed, there is risk for soil and groundwater contamination.

From a sustainable point of view, recovery treatments are preferred. They comprise of recycling but also incineration when the energy value of plastic is recovered. However, these two alternatives also present disadvantages. The global warming potential of incineration is between 6-7 tonnes CO_2-eq/kg plastic waste which is equivalent to the CO_2 emission of 1.5 cars driving for a year per kilogram of plastic waste and higher than landfill global warming potential (5-6 tonnes CO_2-eq/kg plastic waste) [3, 4]. Recycling of plastic waste is constrained by waste contamination, separation challenges and poor quality of some of the products.

Hence, in recent years research was focused on other treatments such as gasification and pyrolysis which not only present low carbon emission (<1 tonne CO_2-eq/kg plastic waste) but also transform a waste into a resource again.

III. Conventional pyrolysis of plastic waste

Plastic waste pyrolysis is a thermo-chemical decomposition in the absence of oxygen which yields an oil/wax product, pyrolysis gas and solid residue. Composition of each fraction largely depends on the composition of the feedstock, pyrolysis temperature, heating rate and residence time.

In general, thermoplastics (HDPE, LDPE and PP) yield mostly wax (80w/w%), formed by a mixture of aliphatic hydrocarbons; low pyrolysis gas (20w/w%), comprised of hydrogen and light hydrocarbons; and very low solid residue (<1w/w%). When PS is introduced, the wax transforms into a liquid product with relatively high aromatic content similar to fossil fuels (i.e. gasoline, diesel, kerosene, lubricants, etc.).

Despite all the applications of conventional plastic pyrolysis products, this process is associated with high operating costs, and relatively poor quantity and quatity of some of the products.

IV. Advanced pyrolysis of plastic waste

Advanced pyrolysis such as the use of a catalyst, microwave or plasma could enhance cracking of plastic waste polymer chains improving the quality of the products. They can also be used to promote the amount of monomer recovered from thermoplastics pyrolysis in the gas fraction. The latter increases the sustainability of the process since it closes the loop of platic products life (monomer – plastic product use – pyrolysis – monomer) and decrease the amount of petrochemical resources used to manufacture plastic products in the first place.

Research has been mainly focused on the use of catalyst (specially zeolites) and thermal plasma. Although promising results have been reported, zeolites and thermal plasma increase operating cost and environmental impact. However, non-thermal plasma could be used to assist pyrolysis due to the high energy of electrons which enhanced cracking. So far, monomer yields of up to 25wt% of the initial plastic weight were recovered with non-thermal plasma assisted fast pyrolysis of high density polyethylene at temperatures between 600-700ºC.

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Thermofluid Optimisation of Turboexpanders for Mobile Organic Rankine Cycle Applications

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I. Background

Internal combustion engine and vehicle manufacturers are investigating new technologies for improving vehicle efficiency, driven by a worldwide concern for lowering transport-related CO2 emissions. For a typical vehicle, 22-35% of the energy contained within its fuel is rejected, via the exhaust, into the atmosphere. This source of loss therefore offers an excellent opportunity to implement waste heat recovery systems, increasing vehicle efficiency to reduce emissions and fuel consumption.

II. Organic Rankine Cycles

The organic Rankine cycle (ORC) is based upon the traditional Rankine cycle, a thermodynamic process used within the vast majority of electricity generation plants worldwide. The principle is strikingly simple – a heat source (typically the burning fossil fuels, or a nuclear fission reaction) boils water at high-pressure, to produce vapour. This high-energy gas is then expanded through a turbine, which provides electrical power via the attached generator. The water is subsequently condensed back into a liquid and pumped around in a closed loop, sealed from the environment. Such a process can be adapted for lower temperature applications (such as vehicle waste heat recovery) by simply exchanging the working fluid from water to one with a lower boiling point. A range of organic fluids are available for this purpose, allowing the cycle to be tailored to a specific application.

Whilst ORCs have been used primarily for stationary power generation since the 1960s (solar, biomass), its use for vehicle energy recovery has been largely unexplored, historically due to emissions regulations being met via more conventional means. In the wake of more stringent regulations there has been a resurgence in mobile ORC research, with a number of test demonstrators commissioned. The technology is extremely promising and has shown to deliver up to 13% improvement in fuel economy for heavy-duty vehicles [1].

III. Research Focus

A significant issue holding back the proliferation of mobile ORC is the poor efficiency achieved by turbines when used within such systems, leading to reduced overall performance. This is primarily due to the majority of turbomachinery design methods having emerged from the post-WW2 era, where ideal gas turbines (using air as a working fluid, as seen in civil and combat aircraft) were of key importance.

Unfortunately, the properties of organic fluids deviate significantly from those of ideal gases, meaning that using existing turbine design methodologies are no longer appropriate. Additionally, there is a significant shortage of experimental data to validate ORC turbine designs, meaning that performance predictions are made with little confidence. The focus of this research is therefore to deliver a rigorous design methodology for ORC turbines, to be applied across a range of vehicles and applications.

IV. PhD Outline

The first stage of this PhD project is simulation based, creating the tools required to accurately predict and enhance ORC performance. Initial work focuses upon the generation of a simulation of a complete mobile ORC system. A novel aspect of the simulation was accounting for heat storage within the system and the application of this across entire vehicle operating cycles, allowing a comparison of ORC performance across different modes of vehicle operation. This fed into a process to optimise turbine geometry to give optimal performance across whole vehicle cycles. This process utilised a genetic algorithm, simulating the selection processes occurring within biological evolution, allowing a turbine design to be created that would give optimal efficiency across an entire vehicle operating cycles.

The second stage of the PhD is experimental validation. A novel test rig is therefore being constructed to test turbine designs using ORC working fluids, and take detailed experimental measurements, providing validation of simulation work, and insight into the fluid dynamics of dense fluids.

V. Impact

This research will ensure that robust turbine designs can be delivered with high confidence, developing the tools required to create high-efficiency, environmentally friendly energy recovery systems.

Such work will reduce the energy demands placed upon internal combustion engines, facilitating significant reductions to fuel consumption and CO_2 emissions, and paving the way towards the next generation of advanced vehicle powertrains.

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Diesel Spray under High Gas Pressure Conditions

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I. INTRODUCTION

Injection condition of diesel fuel strongly affects the fuel-air mixture preparation and thus the fuel consumption and emissions of internal combustion engines. The need of higher engine power with lower emissions has to be satisfied in current diesel engine development. From that purpose, mechanical air boosting device such as turbocharger is an essential equipment installed into the diesel engine of passenger car and commercial vehicle. It uses to increase volumetric efficiency by forcing more air into the cylinder which can be mixed with more fuel to create more engine power. In that case, liquid fuel is injected into working fluid which exceeds thermodynamic critical temperature and pressure of the liquid phase. At supercritical state during mixing, liquid structure affected by surface tension diminished [1] is possible to promote a diffusive mixture preparation process rather than atomization process [2]. The present study is a preliminary observation of liquid vaporization near the nozzle tip expected particularly subject to high gas pressure and high temperature.

II. EXPERIMENTAL SETUP

Simultaneous shadowgraph and scattering imaging technique was employed focusing at near-nozzle field region for vapor and liquid phase visualization respectively. In Figure 1, a 640-nm pulsed-diode laser was used as a light source. With this system, the collimated incident laser light was directed through the quartz window placed in front of the compression chamber and illuminated the spray that penetrates along the vertical axis. The ambient gas condition relevant to that used in diesel engine currently exceeds 4 MPa and 800 K for pressure and temperature respectively. Therefore, the experimental gas condition were prepared based on the actual operation and the critical point of liquid fuel which

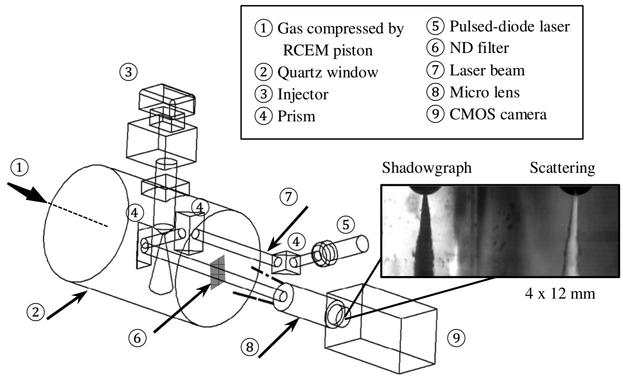

Figure 1. Optical arrangement for simultaneously microscopic scattering and shadowgraph imaging

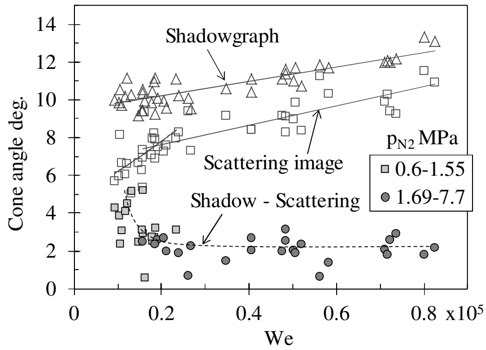

Figure 2. Effect of Weber number on cone angles

is 1.6 MPa and 677 K for pressure and temperature respectively. A wide range of cone angles were observed ranging from the gas conditions of 0.6 MPa and 506 K through 7.7 MPa and 940 K for pressure and temperature respectively.

III. RESULTS

The cone angles of all gas conditions measured from shadowgraph, scattering images and calculated cone differences are displayed in Figure 2. The Weber number of fuel at the inlet was used for describing the early stages of jet breakup. It can generally be seen that cone angles considerably increase with increasing Weber number. This is because the increased of gas density amplify aerodynamic interaction force between liquid fuel and gas phase flows that can be responsible for enhancement of liquid atomization. For gas pressure ranging between 0.6 – 1.55 MPa, significant change in scattering cone angles obviously exhibited. It can be said that scattering cone angle was very sensitive at low Weber number associated with subcritical gas pressure and likely became insignificant at high Weber number.

IV. CONCLUSIONS

Cone angles obtained from shadowgraph and scattering imaging technique can describe behavior of fuel-gas mixture. The scattering cone angle was found to be sensititive at low Weber number. Additionally, it was believed that the light can be scattered even by supercritical mixing region due to continuously increasing of scattering cone angles with respect to gas pressure and temperature.

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Innovative Vehicle Load Sensing System for Orthotropic Steel Deck Bridges

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I. Introduction

Rib-to-deck (RD) welded joints in orthotropic steel deck (OSD) bridges are subjected to very localized out-of-plane bending moment from vehicle wheel loads. Fatigue damage has been observed in RD joints, resulting from high cyclic stresses in combination with inadequate welding details. Therefore, efficient vehicle load sensing is critical for fatigue evaluation enhancement. Although reasonable prediction of vehicle load has been achieved using foil strain gages, the conventional strain gage based approach may be an expensive process and not appropriate for bridge spans with short influence line such as OSDs. Therefore, an innovative sensing system is proposed for vehicle load sensing in OSDs (Fig. 1). Piezofilm (PVDF) sensor (Fig. 2) with its excellent signal-to-noise ratio, dynamic sensing and power generating ability can be an alternative for strain gage. Since PVDF sensor typically covers a large area of the hosting structural member, the mechanism of converting strain to sensor's output voltage would be investigated. Also a study on PVDF sensor's low-frequency performance would be conducted since bridge structural responses usually contain the low-frequency components.

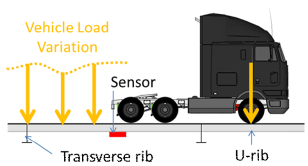

Figure 1. Vehicle Load Sensing for OSD

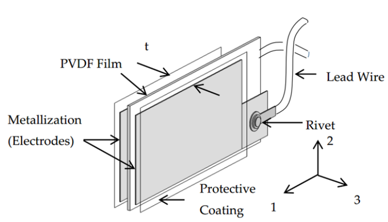

Figure 2. Configuration of PVDF sensor

II. Sensor Performance at Low-Frequency

Tensile tests using standard tensile specimens (Fig. 3) subjected to cyclic loading were conducted. Eight frequencies ranging from 0.1 to 20 Hz and six strain amplitudes ranging from 1 to 139.8 με. Correlation between load and sensor output indicates the superior performance of PVDF sensor at low strain level. PVDF sensor exhibits consistent performance regardless of strain amplitude and frequency.

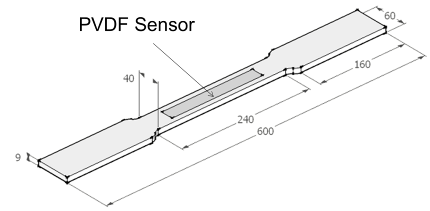

Figure 3. Tensile specimens subjected to cyclic tensile loading

III. Mechanism of Strain Conversion to Voltage

A numerical simulation based on knowledge of piezoelectricity, Bernoulli beam vibration, and equivalent electrical circuit was proposed to predict the output voltage of PVDF sensor attached to a steel cantilever beam subjected to input impact forces. To verify simulation results, impact tests were conducted using impact hammers at three locations, i.e. 1, 2, and 3 (Fig. 4). PVDF sensor DT4-028K/L w/rivets was employed.

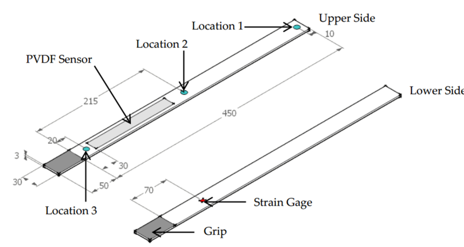

Figure 4. Cantilever beam subjected to impact forces

Simulation results show that the sensor's output voltage can be reasonably predicted by the numerical simulation for all three impact locations. A larger sensor tends to generate a higher output voltage. The effect of sensor position seems to be more significant for larger sensors. However, when a large number of modes are excited, increasing sensor size may not always result in an increased output voltage beyond a certain sensor length due to mode shape slope cancellation problem.

IV. Conclusions

Overall, PVDF is proposed to be an alternative to conventional foil strain gages for the innovative vehicle load sensing system in OSD bridges.

Sterilisation Challenges of Bioresorbable Medical Devices

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I. Introduction

The next generation of orthopaedic implants will consist mainly of bioresorbable materials, these have the advantage of not needing a second, removal surgery. Like all devices, these need to be sterilised prior to implantation in the body. The most frequently used industrial sterilisation methods are ethylene oxide (EtO), gamma irradiation (GI) and electron beam. EtO requires a humid atmosphere which can degrade bioresorbable polymers, electron beam has a low penetration power compared to GI and GI can cause changes to material properties. Poly(lactide co-glycolide) (PLGA) is a bioresorbable polymer which is used in commercial products such as the Regenesorb Healicoil [1]. GI sterilisation has been found to degrade and reduce the tensile strength of PLGA [2].

In order to reduce the negative effects, GI at low temperature or in an inert atmosphere has been explored. This has been effective at limiting material changes, however it may compromise sterility assurance levels (SALs) [3,4]. A method of irradiating devices without affecting the properties whilst achieving SALs is highly desirable. The aim of this study, was to combine low temperature and inert atmosphere to minimise the negative effects of GI on PLGA.

II. Materials and Methods

PLGA was compression moulded into sheets at 200°C which were irradiated using a cobalt-60 source at Nordion Inc., Canada. Samples were irradiated in nitrogen at 40 kGy at 25 and -80°C and characterised using tensile testing, differential scanning calorimetry (DSC), gel permeation chromatography (GPC), nuclear magnetic resonance (NMR) and Fourier transform infrared spectroscopy (FTIR).

The project will also include a study of Poly(d,lactide co-glycolide) (PDLGA) which will be similar to the one on PLGA. It will look in more detail at the effects of temperature and atmosphere on a bioresorbable polymer. A third irradiation study has also been planned on a non-polymeric material which has been found to be radiation sensitive.

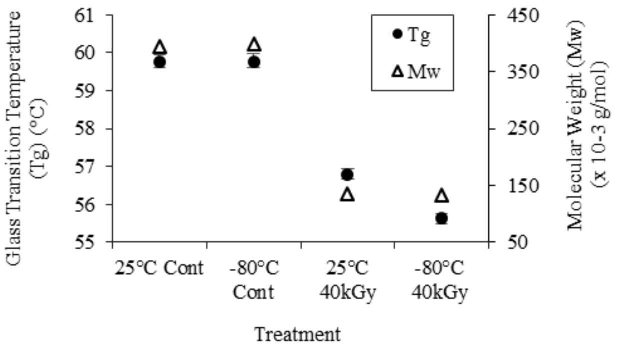

Figure 1 – Glass transition temperature and molecular weight of PLGA after different irradiation treatments.

III. Results and Discussion

PLGA was found to be affected by the GI, mainly through chain scission. This was observed in the DSC results by a reduction in the glass transition temperature (T_g) from 59.8 to 56.8°C and the GPC showed a decrease in the molecular weight from 397 000 to 134 000 g/mol as seen in Figure 1. The radicals created in this process have been identified from the literature [5].

The mechanical properties were found to be significantly similar where $p > 0.999$ for percentage strain. FTIR and NMR showed subtle changes in their spectra after irradiation but they were not large enough to be considered significant.

The only variable that a significant difference was found between the -80°C and the 25°C irradiated samples was T_g, all other variables were similar. This difference between the T_g values, however, was less than 1°C.

IV. Conclusion

In conlusion, when PLGA was irradiated at 25 and -80°C in nitrogen, chain scission occurred which formed radicals. These radicals have been identified from the literature. The sterilisation temperature did not have significant effect on the material properties in practice.

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Upgrading Pyrolysis Vapors using Supported Ionic Liquid [bmim][BF4] Catalyst

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I. Introduction

Recently, countries around the world require more energy due to increased industrialization. Oil and gas are limited resources, however, biomass is clean, reliable, and the only renewable carbon containing feed stock that can be used for the synthesis of hydrocarbon transportation fuels [1]. Pyrolysis of biomass is highly efficient process to produce bio-oil with yields up to 70% and low capital investment [2].

Pyrolysis oil is low quality and needs to be upgraded. Recently, acidic ionic liquids have been used to upgrade the bio-oil in the liquid phase. The energy content increased from 17.3 MJ/kg to 24.6 MJ/kg [3]. Also, supported ionic liquid phase (SILPs) catalysts have been used recently in gas streams as a desulfurization agent [4]. However, as far as we know, SILPs have not been used to upgrade pyrolysis vapors in the gas stream. Therefore, SILPs were synthesized on ZrO2&TiO2 (ZTO) and silica beads and tested for upgrading pyrolysis vapors.

II. Methods

Wood (Hinoki) chips and synthesized catalyst were loaded in the fixed bed pyrolysis chamber and catalyst reactor respectively. Nitrogen gas stream was used to eliminate the oxygen in the chambers. The catalyst reactor was increased to 225°C. Finally the pyrolysis was started by increasing the temperature of the pyrolysis chamber to 500°C. The vapors flowed over the catalyst and then condensed in a round bottom flask submerged in an ice bath. The bio-oil was analyzed with H-NMR.

III. Results

The bio-oil quality was calculated by adding the percent area of the alkane and aliphatic region of the H-NMR. The bio-oil quality for the coated silica beads and ZTO are shown below in Figure 1 and Figure 2.

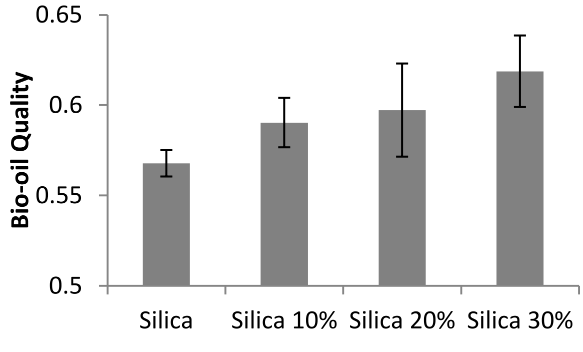

Figure 1. NMR results of bio-oil quality for coated silica with [bmim][BF4]

As can be seen from Figure 1, when the percent of ionic liquid coating increases from 0% to 30%, the bio-oil quality improves from 0.56 to 0.63. The Brønsted acid sites from the ionic liquid help improve the quality of the bio-oil by increasing the amount of alkanes and aliphatics through deoxygenation reactions.

From Figure 2, the opposite trend is seen. The uncoated ZTO support promotes catalytic deoxygenation due to the active metallic sites on the catalyst support. Coating the support with [bmim][BF4] decreases access to the active sites and decreases bio-oil quality.

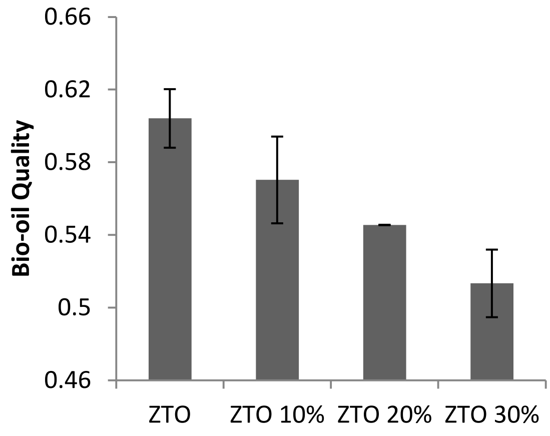

Figure 2. NMR results of bio-oil quality for ZTO with [bmim][BF4] coatings

IV. Conclusion

H-NMR was conducted on bio-oil catalyzed with coated silica bead and ZTO. The [bmim][BF4] increased the deoxygenation reactions on the silica beads but decreased the deoxygenation reactions on the ZTO catalyst support. Further research is needed to optimize the ionic liquid type and determine the bio-oil chemical composition.

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Insights into Hydrogen Oxidation Process at Ni/YSZ anode in Solid Oxide Fuel Cells based on Species Territory Adsorption Model

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I. INTRODUCTION

Solid oxide fuel cells (SOFCs) has been identified as one of the next-generation energy conversion devices, which can convert chemical energy of various fuels such as hydrogen, carbon monoxide, and hydrocarbon to electrical energy directly. The oxidation reaction of these fuels on anode is one of the key processes in SOFC operation, and it is important to understand reaction mechanism of these fuel oxidation reactions for further development of anode material design. As an anode material for SOFCs, cermet electrode of Ni and yttria-stabilized zirconia (YSZ) is widely used because of its high catalytic activity for hydrogen oxidation reaction and high chemical stability at elevated temperature. Hydrogen oxidation reaction is considered to occur at the Ni-YSZ-gas triple phase boundary (TPB) because this reaction involves hydrogen gases, oxide ions, and electrons.

Recently, we have developed analytical model of hydrogen oxidation reaction at the TPB on SOFC anode (species territory adsorption model) [1]. Based on the model, analytical expression of anode overpotential with current density was derived explicitly. This expression could combine the anode overpotentials at low and high current density regions, which were conventionally expressed independently, to unique expression The analytical results agreed well with experiments while all reaction parameter, such as equilibrium constant and reaction rate constant was determined by fitting to experimental results, and there was no thermodynamic consideration in the previous work [1]. In this study, reliability of the model was improved through the introduction of thermodynamic consideration and reaction rate constants. Some of thermodynamic and kinetic parameters were referred from density function theory (DFT) calculations [2, 3], resulting in a reduction of fitting parameters.

II. SPECIES TERRITORY ADSORPTION MODEL AND COMPARISON TO EXPERIMENTAL RESULTS

The details of the reaction model were shown in our previous work [1]. The analytical expression of anode overpotential as a function of current density derived from the model is shown in Figure 1. Here, C_1 and C_2 are

$$\eta_a = \frac{RT}{2F}\ln\left[\frac{(1+K'_{\mathrm{H_2O}}P_{\mathrm{H_2O}})i + C_2}{K_{\mathrm{O}}(C_1 - i)}\right] - \frac{\Delta G_f{}^{\circ}(\mathrm{H_2O})}{4F} - \frac{RT}{2F}\ln\left[\frac{P_{\mathrm{H_2O}}}{P_{\mathrm{H_2}}}\right]$$

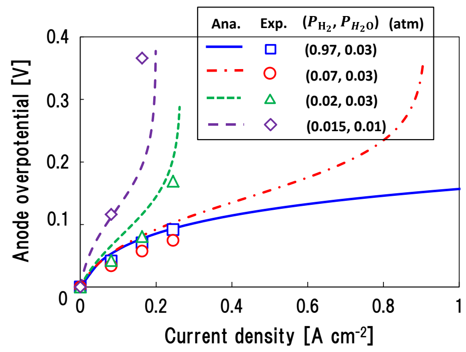

Figure 1. Analytical and experimental results of anode overpotential for Ni/YSZ anode at 800 °C under various atmosphere compositions. Analytical expression of anode overpotential is also shown.

functions as partial pressure of hydrogen and water vapor, equilibrium constants, and surface reaction rate constants. Equilibrium constants and surface reaction rate constants are determined from van't Hoff equation and Arrhenius equation, respectively. Some of thermodynamic and kinetic parameters substituted into those equations were referred from DFT calculations [2, 3], resulting in a reduction of the number of fitting parameters to half or less.

Fig. 1 shows a comparison between analytical and experimental results of anode overpotential for Ni/YSZ anode at 800 °C under various atmosphere compositions. As shown in Fig. 1, the model agrees well with the experimental results under wide range of hydrogen partial pressure conditions. Here, only three fitting parameters are required for the calculation of analytical results, that is, enthalpy and entropy for oxygen adsorption on YSZ, and frequency factor for surface reaction.

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A systems approach to developing a new metro for the future of megalopoleis

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I. Introduction

With the dominance of the automobile in the urban landscape of many megalopoleis, cities have outgrown the ability of public transport systems to offer door-to-door speeds that are appropriate for the area to be served. Research shows that, throughout history, cities have been one hour wide [1]. However, differently than how the railways shaped the metropoleis in the 19th century, car-driven cities stretch beyond this linearity and challenge the sustainability of transport systems [1, 2].

A study by Gyimesi et al [3], with 8,000 drivers in 20 of the world´s largest cities, found that the average distance commuted by drivers is 19.7 km, covered in 33 minutes. In these cases, the average door-to-door speed offered by the car is 35.8 km/h. When the same trip is simulated on a metro system, the minimum door-to-door journey time achievable over the same distance is approximately 44 minutes, resulting in a door-to-door speed of 26.9 km/h. In this paper, we have used the design parameters used by Siemens [4].

Even though metro systems can achieve higher maximum line speeds than those permitted on roads, their main disadvantage lies in the coverage paradox. The journey by car involves mainly a motorised component while the same journey by metro involves at least two components, one of individual access to stations where distance is the critical factor, and in-vehicle time where speed is the critical factor. Hence, if stations are far apart, a metro will have a higher average in-vehicle speed, but access time increases as well. Conversely, when stations are close together, access is fast but the average in-vehicle speed on the metro is reduced. In both cases, their door-to-door journey times are significantly higher than those of private modes.

Therefore, in order to restore the competitiveness of metro systems in individual transport oriented environments, it is necessary to overcome the coverage paradox and increase the average door-to-door speeds. Yet, simply increasing the maximum line speed does not appear to solve the problem. A 40% increase in maximum line speed to 126 km/h would only result in an increase of 3.3% in door-to-door speeds. This is because most metro systems stop at all stations along the line, which inevitably reduces the average speed to approximately one third of the top speed.

II. Operational Concept

Based on that, we propose an operational concept that solves the coverage paradox and is able to offer door-to-door speeds greater than those achievable with automobiles. This is made possible using an operational strategy that assigns different stopping patterns to services, with station platforms located off the main line. The pattern system reduces the number of stops between origin and destination and consequently increases the average in-vehicle speed of passengers. Moreover, when stations are off the main line, the headway time can be reduced to a minimum, which significantly increases the capacity of the system. These concepts create further functional requirements that will direct the technical and technological development of components so as to meet the future objectives. For example, services shall be provided by platoons of autonomous vehicles instead of regular trains in order to offer every pattern to every user at every station at the minimum headway. Simulations of the concept show an increase in the average in-vehicle speeds of 100% and a reduction in door-to-door journey times by approximately 35%. Because headway times are also reduced, a 10-vehicle platoon model can increase the theoretical capacity of the system by 30% when compared to the busiest conventional line in operation.

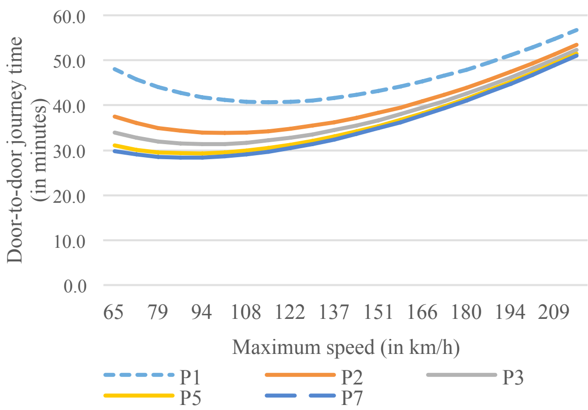

Figure 1. Door-to-door journey times of different patterns for a 19.7 km journey

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Encouraging Knowledge Sharing

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I. Introduction

Incentives are a crucial part in encouraging knowledge sharing between organization members[1]. However, there is no clear understanding of the factors that influence incentive effectiveness as various studies have shown that similar incentives have varying outcomes[2,3].I argue that this is due to failure to understand contextual factors of the incentive. To improve the design a new theory has been proposed and corroborative evidence has been gathered. This abstract will detail the new contributions.

II. New Framework

In order to better understand the contextual factors that incentives have, a new frame work has been proposed. The framework is based on the previous work by Bowles & Polania-Reyes[4], signaling information of incentives, and Fiske's [5], relational models. These two theories cover how the incentives incluence the individuals engaged in sharing activities as well as its influence on the organization's sharing culture.

The incentive's influence on short-term behavior can be analyzed through state-dependent preferences of the interacting individuals and through the governing rules of the relation. Long-term effects of the incentive can then seen in the udpdated exogenous preferences of the actors. A more detailed analysis of the proposed framework can be found in [6].

For the incentive creator, e.g. management or consultants, this framework offers a more detailed insight into what influences knowledge sharing practices in organizations. In previous studies, such as [1], [2] and [3], the influence of organizational and relational context to sharing has not been fully considered. The new framework is designed to capture the contextual factors and therefore it has more accurate prediction power than previous frameworks.

III. Implications

The new framework carries with it numerous implications on how incentives should be configured. First, it implies that incentives are fundamentally context-dependent. This means that in order to create effective incentives for collaboration, the contextual factors of the organization need to be understood. One way to do this would be for the incentive creator to sped time observing and analyzing the interaction inside the organization. Through analyzing the interaction incetives can created in such a way that they aligned with the interests of the organization and the indivual.

Second big implication of the framework is that incorrect configuration of incentives can break the culture of sharing. This will lead to decreased collaboration levels and ultimately hinder the organization's innovativeness. It also predicts that rectifying the damage done by the misaligned incetives will be very difficult as the updating the collaboration preferences of individuals will be challenging due to exogenous preferences.

IV. Future Research Directions

Future research on the framework will concentrate on testing the extreme cases predicted. For example, based on the framework it can be predicted that more tighter-knight organizations would use less incentives targeted at collaboration. It also predicts that organization's industry affects the incentive that can be used. Finally, the framework also predicts that conflicts in signaling caused by the introduction incentives will result in decreased sharing levels and harm the culture of sharing in the organization.

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A 56Gb/s W-Band CMOS Wireless Transceiver

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I. Introduction

One of the most important requirement of tomorrow's wireless technology is to achieve Gb/s order data-rates. It can be observed from [1] that the most effective modulation scheme under certain conditions is 16QAM. For example, to achieve 100Gb/s wireless data-rate with 16QAM modulation, one need 25GHz of bandwidth. For a single stream data, the baseband processing and conversion required high-power consumption and large die area. To achieve high data-rate wireless communication while considering all system requirements, in here, a W-band frequency-interleave transceiver is proposed [2].

II. Proposed W-Band Tranceiver

Fig. 1 illustrates the frequency-interleave W-band transceiver block diagram. There are two IF data inputs for the transmitter (TX). One is for low-band (LB) which is up-converted with 68GHz LO signal generated from a frequency doubler from 34GHz LO. The doubler and tripler are common for TX and receiver (RX). The other one is for high-band (HB) which is up-converted with 102GHz LO signal generated from a frequency tripler from 34GHz LO. The PA and LNA works from 68 to 102GHz. The millimeter-wave amplifiers are based on feedback common-source topology to boost the gain at W-band. Following the LNA, one-stage RF buffers are included to divide the bandwidth into two. Wideband IF amplifiers are connected before the RX outputs.

III. Measurement Results and Conclusion

W-band transceiver is manufactured on 65nm bulk CMOS technology. The chip photo is illustrated in Fig. 2. Total die area including pads is 2x3mm2. The TX-to-RX measurements are done and for the max data-rate of 56Gb/s. 6.5GHz bandwidth from the low-band and 7.5GHz bandwidth from high-band is used to achieve a total of 14GHz data bandwidth. Fig. 3 shows the transmitter output spectrum for 56Gb/s data communications. Fig. 4 shows the performance results with literature CMOS based high-data-rate transceivers. To conclude a world-record of 56Gb/s wireless communication is achieved at W-band using CMOS circuitry.

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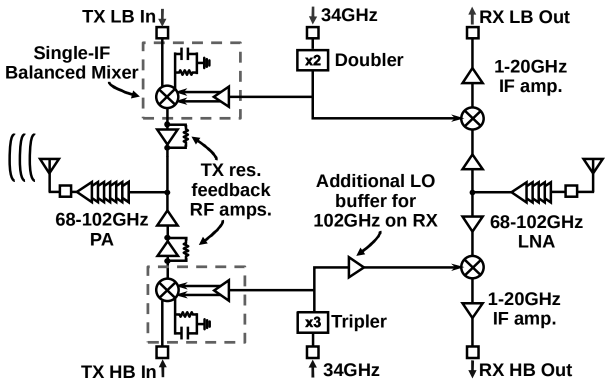

Figure 1. W-band frequency interleaved transceiver block diagram.

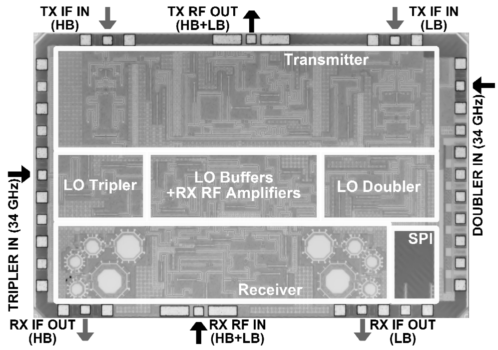

Figure 2. W-band transceiver chip photo. Total area is $2x3mm^2$.

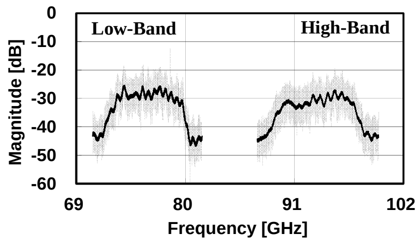

Figure 3. Transmitter output spectrum for LB and HB.

Reference	[3]	[4]	This Work [2]
Integration	TX, RX	TX Only	TX, RX
Frequency [GHz]	57-66	300	68-102
Data Rate/ Modulation	28.16 Gb/s (16QAM)	30 Gb/s (32QAM)	**56 Gb/s (16QAM)**
TX-to-RX EVM [dB]	-17.2	—	-16.5
Technology	65 nm CMOS	40 nm CMOS	65 nm CMOS
Energy Efficiency [pJ/bit]	16.73	47	10.0
Power Consumption [mW]	TX: 251 RX: 220	1400	TX: 260 RX: 300

Figure 4. Performance comparison of high data rate transceivers.

A New Unsteady Flow Optimization Method for Enhanced Exhaust Emission Reduction

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I. INTRODUCTION

Increasingly strict legislation is being produced worldwide towards exhaust emission (Figure 1). The turbocharging is a proven tech-nology that recovers energy from the exhaust emission to boost an engine. With a turbocharger, the engine can be downsized to re-duce the exhaust emissions without decrease in power output. However, a big challenge for a turbocharger is the unsteady ex-haust flows. The exhaust flows produced by the engine is highly pulsating, which is difficult for the turbine to fully adopt. This leads to the deterioration of the turbocharger performance, and further leads to that less than 40% of the energy in the exhaust emission can be recovered at best.

In order to further exploit the potential energy in the unsteady exhaust flow, a new 'unsteady flow optimization method' was proposed. This new method has been validated by experimental testing to be able to notably increase the turbine efficiency (7%~20%), and this indicates the new method can effectively improve the performance of a turbocharger, leading to better en-gine performance.

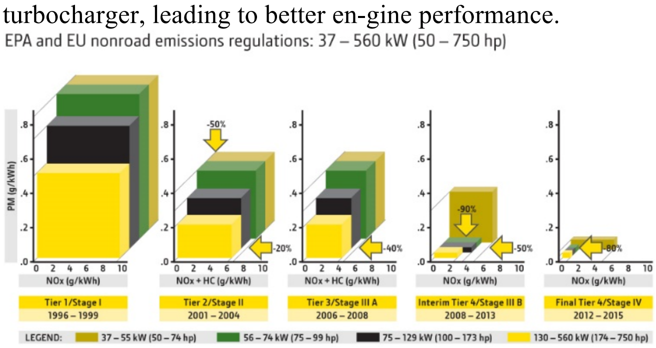

Figure 1 Increasingly stringent legislation towards exhaust emission in the last 2 decades

II. THE CONCEPT OF THE UNSTEADY FLOW OPTIMIZATION METHOD AND SOME EXPERIMENTAL RESULTS

The new method is to improve the turbocharger performance by means of a specially designed 'rotating nozzle ring' shown in Figure 2. Different from traditional turbocharger configuration in which the nozzle ring is stationary, the rotating nozzle ring rotates as a unit in the same direction as the turbine. The operating prin-ciple is that with the rotating nozzle ring, the fluctuation of the exhaust flows at the turbine inlet can be mitigated, which is easier for the turbine to receive.

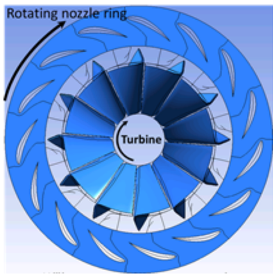

Figure 2 The new rotating nozzle ring

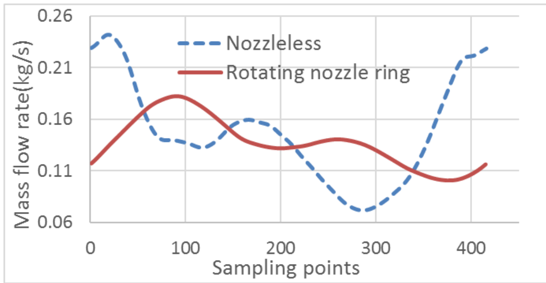

Figure 3 Experimental results showing the reduction of the fluctuation of the air mass flow rate

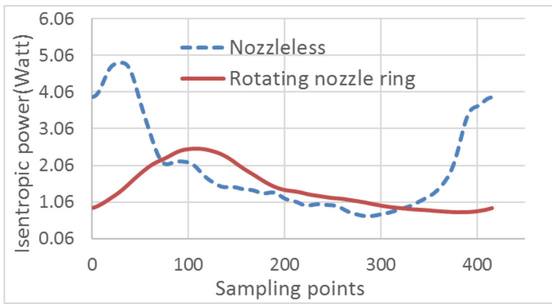

Figure 4 Experimental results showing the reduction of the fluctuation of the turbine power

As shown in Figure 3 and 4, with the rotating nozzle ring, both the air mass flow rate and the turbine power become flatter through an exhaust cycle, and this leads to an efficiency increase of 7% in this case.

III. CONCLUSION

A new 'unsteady flow optimization method' is introduced in this research, aiming to improve the turbocharger performance. Experimental testing has validated this method with promising result being obtained. This indicates that with this technology, the vehicle exhaust emission can be further reduced to a new level that the current air-charging technology cannot achieve.

Evaluation of sediment dynamics in mountainous watershed with GIS and XRF

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I. Introduction

Recently, heavy rainfall often causes a large amount of sediment flow into a river in mountainous area, Japan. This phenomenon adversely affects safety and functions of a dam for water resources. In order to solve the problem about river sediment, it is important to understand the sediment dynamics in mountainous streams. However, sediment volume and flow rate are measured just inside a dam reservoir in most cases. It is still unclear how much sediment is transported from tributaries.

Numerical simulation for riverbed deformation is one of the methods to evaluate sediment dynamics in a river. The dynamics of coarse sediment (> 2mm) were calculated with the one-dimensional riverbed deformation model [1], however it can only estimate gravel sediment. Because sediment dynamics clearly depend on sizes and forms of sediment particles, multiple methods should be applied to evaluate their movements. It is quite difficult to understand sediment transport situation with one method.

II. Method

In this study, sediment dynamics has been evaluated with topographical analysis, chemical analysis, hydrological modelling in the Nanatsuyamakawa river basin, Miyazaki, Japan. The geology of the study area is composed of Chichibu Belt (Paleozoic chart and limestone) and Shimanto Super Group (Mesozoic and Cenozoic sandstone and mudstone). The topographical analysis was carried out by geographic information system (GIS) to clarify topographical characteristics of catchments and to select sampling sites of river sediments. Chemical compositions of river sediments were analysed by XRF to reveal contributing ratios of each geology to fine sediments (< 2mm). Hydrological properties of the watershed were modelled with TOPMODEL [2] and topographical data and flow-rates in 2015. The properties and topographical data were used as basic parameters for satatistical analysis to reveal factors associated with sediment dynamics. The result of chemical analysis was compared with satatistical analysis results and previous studies [3], conformity of these results was estimated.

III. Conclusion

As a result, the followings have been summarized. (1) The GIS and statistical analysis have shown that slope angle, bare land area, and annual rainfall are playing a major role in sediment transport, moreover, forest area helps to suppress the sediment transport on hill-slopes. (2) The chemical analysis of sediments has revealed that mud-stone contributes more to sediment transport than sandstone of Shimanto Super Group. (3) Sediment flow ratio of tributaries was estimated from geological composition, this esitimation was related to relief ratio and slope angle and etc.

These results are integrated from former researches.

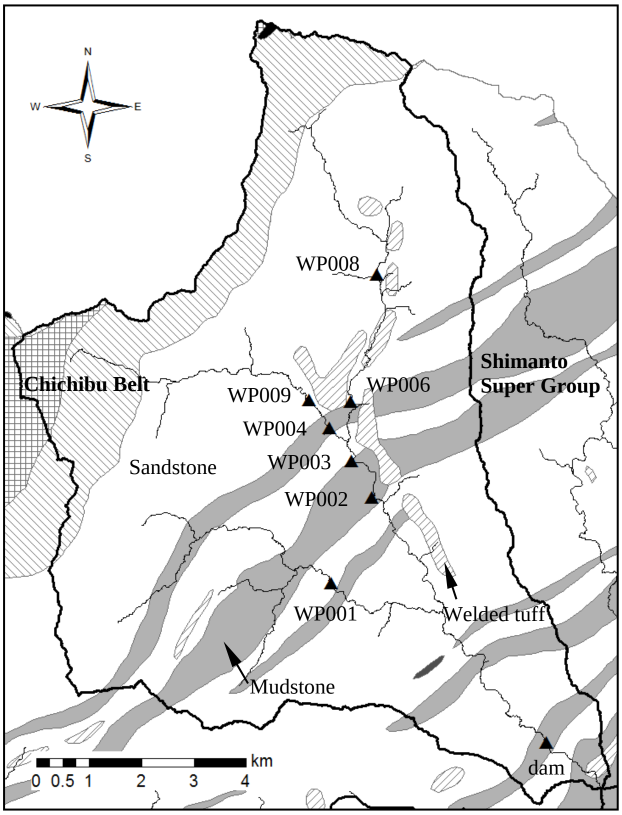

Figure 1. Geological map and sampling sites for XRF

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Design and Development of Bridge Vibration Energy Harvester using Tuned-Mass Systems

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I. Introduction

Energy harvesting from structural vibrations has been studied in various fields and one area of growing interest is the potential for this harvested vibration energy to supply electric power to wireless sensors, or other intelligent systems, for the health monitoring of bridges [1, 2]. There is also the prospect for energy harvesting from bridge vibration to charge batteries, and apply this electric energy to various other systems.

So far, tuned mass damper have been studied to control bridge vibration. Tuned mass damper systems can control bridge vibration when an ideal dynamic balance is achieved between its masses, springs and dampers. If a transducer replaced the damper in tuned mass damper systems and could successfully absorb vibration energy, it would have the capacity to harvest energy or control bridge vibration. However, one problem concerning energy harvesting from bridge vibration is that the natural frequency of bridges is uncertain due to many factors including traffic conditions and temperature. Nonetheless, the performance of tuned mass damper systems is highly sensitive, and can drop with the slightest change.

In this study, an energy harvester using a tuned dual-mass damper system and electromagnetic transducer, named hereafter Tuned Mass Generator (TMG), has been proposed. In addition, the proposed design method for this TMG considers the purpose of energy harvesting to achieve greater power generation from bridge vibration.

II. Parameter Design of TMG systems

A. *Theoretical explanation of TMG systems*

Figure 1 shows a Tuned Mass Generator (TMG) with dual-mass systems, where two masses are connected in series with springs. An electromagnetic transducer is installed between the two masses. Based on Faraday's law, the damping force by the transducer is formularized as

$$F_e(t) = k_{emf} I(t) \quad (1)$$

Where k_{emf} is an electromotive force coefficient [Vs/m]. Normalized vibration amplitude and electric power response $\overline{X}$ and $\overline{W}$ are introduced as follows

$$\overline{X} = \frac{X}{F_0 / K}, \quad \overline{W} = \frac{RI^2}{F_0^2 / \sqrt{KM}} \quad (2)$$

B. *Multi-domain parameter design method*

The purpose of parameter design is to maximize power generation and ensure robustness against changes in vibration frequency. In this study, it has been proposed that to ensure robustness against changes in vibration frequency, the amplitude of harvesting power response $\overline{W}$ in the equation (2) must satisfy the minimum amplitude of harvesting power $\overline{W_c}$ in the range between the normalized excitation frequencies, using a constraint function.

III. Conclusions

The required TMG characteristics have been formularized which makes use of the unused reserve of energy in damper systems to harvest energy. In addition, the design method has been developed to tune this TMG. Finally, there is also the potential for the proposed TMG to be further developed so that if parameters of the electromagnetic transducer can be controlled, applicability and performance of power generation could improve.

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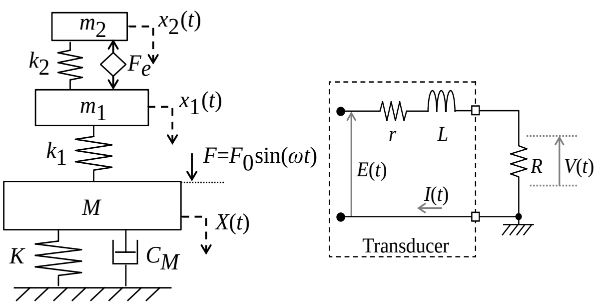

Figure 1. Analysis model of the TMG system.

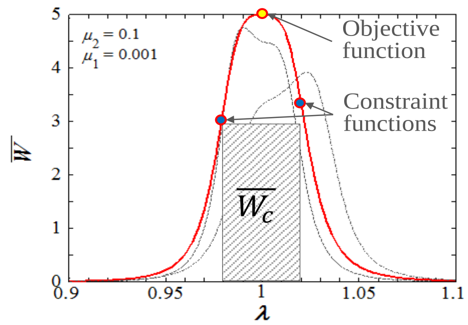

Figure 2. Power spectrum of power generation (dimensionless)..

Synthesis of AlN from sapphire by using reduction-nitridation method in molten salt

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I. INTRODUCTION

Aluminum nitrde (AlN) is an expected material for deep UV light emitted device because of excellent properties; wide bandgap (6.2 eV) and immiscibility with gallium nitride (GaN) in entire composition region. The representative production method of AlN single crystal is sublimation method[1][2]. However the process needs very high operation temperature (~2273 K). As a results, cost of AlN production is very high. Many impurities contained in the crystal from seed and atmosphere are also big problems.

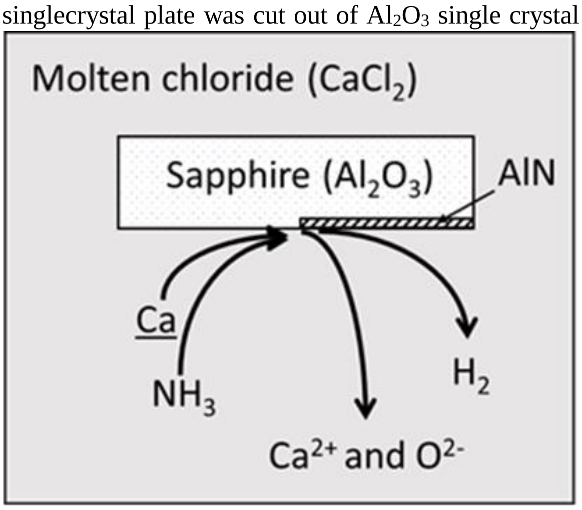
A new method to make AlN from a sapphire (Al_2O_3) at lower temperature by reduction – nitridation in molten chloride was developed in this study. The principle is shown in Fig. 1. The reaction can be described as Eq. (1).

$$Al_2O_3 + 3\underline{Ca} + 2NH_3 \rightarrow 2AlN + 3Ca^{2+} + 3O^{2-} + 3H_2 \quad (1)$$

The mark of this process is that calucium is homogeneously supplied from molten chloride due to high solubility of Ca in $CaCl_2$. The smooth removal of by-product (CaO) because of high solubility of CaO in $CaCl_2$ is also characteristic.

II. EXPERIMENTAL

In a glove box under Ar, $CaCl_2$ (~50 g) was put into a mild steel (or graphite) cruclble and the crucible was put on the bottom of stainless steel reactor. Al_2O_3 singlecrystal plate was cut out of Al_2O_3 single crystal rod (Φ 16) by using diamond saw and polished with diamond file. NH_3 was used as a nitriding agent. Ca was used as reducing agent. For comparison Al plate was used as reducing agent. The sample was heated up to 1123K and held for 3 hrs under Ar flow.



Fig,1 The principle of reduction-nitridation method for synthesis of AlN from sapphire

Ⅲ. RESULTS AND DISSCUSION

Thermodynamically not only calcium but aluminum are able to decrease reduction potential and reduce sapphire. Whereas AlN was obtained in the case of calcium as a reducing agent, while no reaction was observed with aluminum as a reducing agent in molten chloride. This results indicated that the solubility of reducing agent in solvent is necessary for this reaction. In addition, CaO also has solubility into $CaCl_2$, which makes reduction smooth in the reaction. As shown in Fig.2, there are peaks like polycristal. It is speculated that AlN was made on the surface of sapphire substrate and made out of polycristal.

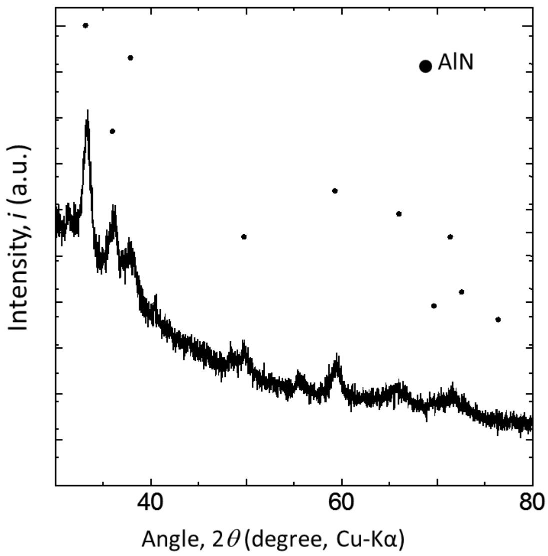


Fig. 2 XRD pattern of the sample obtained through reduction-nitridation method of sapphire

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Development of Clustering Method for Geometry-based Stochastic Channel Modeling

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I. Introduction

Since the prior knowledge of the wireless channel is required for the wireless communication system design, channel model is necessary. The transmitted signal is sent through the channel and interacts with many different interacting objects (IO) in the environment, and this results in several copies of the same signal called multipaths to arrive at the receiver. In the conventional path-based modeling, the channel model is expressed as the summation of several paths, and each path is characterized by the angle-of-arrival (AoA), angle-of-departure (AoD), delay time (DT) and power (P). Recently, geometry-based stochastic channel model (GSCM) has been widely used in which paths with similar routes are grouped into clusters. This greatly reduces the model complexity compared with the path-based model due to less number of parameters. Since the GSCM accuracy strongly depends on cluster estimation accuracy, an accurate clustering method is required. Thus, this paper proposes the geometry-based clustering method for this purpose.

II. Proposed Clustering Method

The proposed clustering algorithm comprises of two steps as shown in Figure 1. Firstly, the measurement-based ray tracer (MBRT) [1] was used to estimate the scattering point of each path from the AoA, AoD and DT of the path. After that, the KPowerMeans (KPM) clustering algorithm [2] was used to group the paths into clusters. This algorithm optimizes the cluster estimation by minimizing the power-weighted physical distance between paths and their cluster centroid (cluster center), which is expressed by.

$$\min \sum_{i=1}^{L} P_i \cdot d_i \quad (1)$$

where L is the number of paths, P_i and d_i are the i^{th} path power and physical distance from its cluster centroid respectively.

III. Results and Discussion

The proposed clustering algorithm was evaluated using measured data obtained using an 11 GHz measurement system in indoor environment [3]. Figure 2 shows the clustering results of the proposed method. It can be seen that the paths were grouped based on the location of the IOs accurately. Figure 3 shows the median of Eigen values comparison between the cluster-based reconstructed channel and path-based reconstructed channel. Eigen value is a parameter which is related to the channel gain of the system. This figure implies that clusters can be used to represent the channel instead of paths since the Eigen value medians are almost perfectly matched.

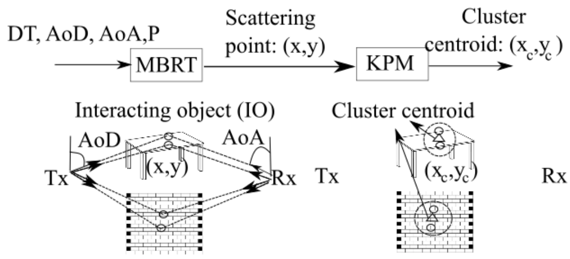

Figure 1. Proposed clustering method illustration

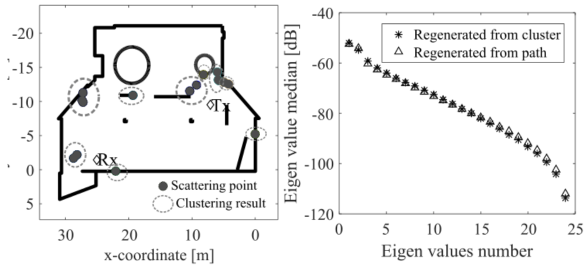

Figure 2. Proposed clustering result

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Development of an online ship performance monitoring system dedicated for biofouling and anti-fouling coating analysis

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I. Introduction

The growing concern for the Green House Gases (GHG) fostered the action of many regulatory organs to further reduce the carbon emissions of seagoing vessels. To compensate for these changes, the pursuit of efficiency optimization became the driver behind all new designs and in-service upgrades of existing ships.

Adverse working conditions throughout the life of a ship increase the powering requirements. Particularly, the abatement of the frictional resistance is critical for a substantial range of big commercial vessels and the impact of bio-fouling on the wetted hull surface is its most arduous cause to prevent and measure.

In this framework, Ship Performance Monitoring Systems are confirming to be a mostly valuable tool to monitor energy flow.

TABLE I.
MEASURED PARAMETERS

Variable	*Device*	*Method*
Speed through water	Furuno and Agilog logs	A
Shaft variables	Design Unit system	A
Position, course and speed over ground	Furuno DGPS and Gyrocompass	A
Wind characteristics	Weatherpak	A
Wave spectrum	Radac Wave Guide	A
Water quality	SeaBird profiling	A
Draught	Visual evaluation	M

II. Research Strategy

A. *Aims and objectives*

The aim of this research is to implement the prototype of the first on-board ship performance monitoring system dedicated to hull micro-fouling and coating analysis. The system aims to derive the impact of hull biofouling with a known and reasonable level of uncertainty.

B. *Methodology*

The Ship Performance Monitoring System is being designed and installed on-board the UNEW's R/V *The Princess Royal* [1] as an automated logging platform. Measured parameters include propulsion-related variables and environmental variables and they are presented in Table 1. During the development of the analysis method, dedicated sea trials are conducted in a partially controlled environment according to [2] and [3].

A reference database of performance data is being built by means of Experimental Fluid Dynamics (EFD) and Computational Fluid Dynamics (CFD) to pattern the behavior of the R/V in design and off-design operation.

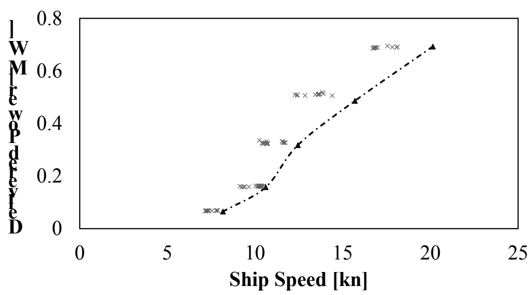

Figure 1. Delivered Power as function of Ship Speed represented as raw (markers) and normalized (line) data.

In-service measured data are thus normalised through appropriate mathematical models by calculating the contribution of every significant external disturbance and thence correcting the measured performance (Fig. 1). The contribution of the pure fouling is derived as a percentage of the total ship power requirement of the reference sea trials (i.e. with smooth and clean hull in ideal calm weather conditions).

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