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Powering DISCOVERIES!

Institute of High Performance Computing
A*STAR

Smooth Sailing For IHPC-SMMI Joint Lab Opening

It's not every day that a lab opening at Fusionopolis has a UK Minister in attendance, which makes the IHPC-SMMI opening ceremony one for the history books.

From left: HE Antony Phillipson, Prof Don Nutbeam, the Rt Hon David Willetts, Prof Raj. Thampuran, Prof Alfred Huan, Prof Ajit Shenoi, and Dr Lou Jing

The opening of the IHPC and Southampton Marine and Maritime Institute (SMMI) Joint Lab, located at IHPC's Fusionopolis offices, on 5 March 2014 marked another epoch not just in terms of cutting edge research projects.

It coincided with the celebration of the 10th year anniversary of the UK-Singapore Partners in Science initiative. Hence, the joint lab launch was graced by many delegates from the UK and Singapore, including the Rt Hon David Willetts, UK Minister for Universities and Science, and H.E. Antony Phillipson, High Commissioner of the British High Commission Singapore.

Fittingly, IHPC and SMMI researchers are embarking on groundbreaking projects under the partnership, to make major strides in academic and commercial sectors of the maritime community.

With the cutting of the red ribbon, the joint lab was ceremonially opened by Prof Raj. Thampuran, Managing Director of A*STAR, and Prof Don Nutbeam, Vice-Chancellor of the University of Southampton, witnessed by the Rt Hon David Willetts and close to 80 partners from academia and industry.

Prof Raj. Thampuran had earlier welcomed everyone with a short address highlighting the significance of UK-Singapore scientific collaborations, and the important role that research and development, as exemplified by the IHPC-SMMI Joint Lab, plays in the global marine and offshore industry today.

The joint lab aims to deepen the understanding of the science and technology deployed in the design, construction and operation of future ships and new offshore structures used in the exploration and extraction of oil, gas and renewable energy sources from deep oceans under extreme, harsh environments. The researchers will translate these insights into impactful industrial applications.

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The Rt Hon David Willetts, UK Minister for Science and Technology, expressing his hopes for even more R&D collaborations between Singapore and UK.

Academia and industry partners from both Singapore and UK were present to witness the opening of the IHPC-SMMI Joint Lab.

*Witnessed by the Rt Hon David Willetts, Prof Don Nutbeam, Vice Chancellor of University of Southampton, and Prof Raj. Thampuran, MD of A*STAR, open the IHPC-SMMI Joint Lab.*

Prof Raj. Thampuran giving the opening address.

The research areas will address two major challenges faced by the maritime and offshore sector:

- **The continuing trend in deep-water offshore oil and gas drilling**, where the main challenge is in the more complex engineering requirements, both in terms of the environment in which the platforms will operate, and in their design and risk analysis based on more reliable scientific approaches.

- **Growth in shipping**, from (a) the increasing size, variety and complexity of ships and, (b) a requirement for vessels to be "greener" from an environmental emissions viewpoint.

The multidisciplinary research leverages the complementary expertise and skillsets possessed by the SMMI researchers, and IHPC research scientists from the Fluid Dynamics and Engineering Mechanics departments. The partnership draws upon IHPC's strength in computational modeling and simulation, and SMMI's strength in marine research.

Located at IHPC, the joint lab will undertake projects in collaboration with other partners in the maritime and offshore R&D community, including researchers from National University of Singapore (NUS).

Prof Alfred Huan, Executive Director of IHPC said: "The collaborations focus on developing solutions in the marine and offshore sector, where the technical challenges are complex and often beyond the capabilities of a single organization."

Given that SMMI is a collaboration between the University of Southampton and Lloyd's Register, and since the IHPC-LR Joint Lab (launched in 2013) is conveniently located next to IHPC, we can expect closer working relations and knowledge exchanges between the researchers in the different joint labs.

The first set of R&D projects include looking at optimizing the design of risers (pipes that transport oil and gas between the seabed and offshore rigs) using composite materials, studying the use of smart materials for marine and offshore use, using fluid dynamics simulations to understand the fluid-structure interactions of riser arrays and the motion of floating offshore structures influenced by current flows.

Networking lunch that followed the IHPC-SMMI Joint Lab opening ceremony.

We look forward to the exciting results of the various R&D projects that will benefit the marine, offshore and maritime industries.

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The happy Computing Science (CS) Department team after the Apps4SG prize presentation.

Dr Qin Zheng receiving the second prize on behalf of the CS team behind Route My Day.

The team gave a demo of Route My Day to Ms Lim Soo Hoon, Permanent Secretary (Finance, Performance), Ministry of Finance. She had time for a short chat and asked questions about the app.

Route My Day To A Big Prize

Introducing Route My Day, a mobile app that makes it easy to plan multiple activities.

The mobile app seeks to do what might seem impossible to busy people with many errands to run at once – that is, to help plan their day by suggesting a route that accomplishes all of their tasks at maximum efficiency.

The app does this by combing through 200,000 location-based service records in mere seconds, and will map out an ideal route that suggests places which cater to these multiple errands or activities as desired.

The team won Second Prize in IDA's Apps4SG competition against stiff competition and walked away with $5000 in cash. There were a total of 89 apps that were in the running. The competition was opened to the public last April. Participants had to submit ideas for apps using government data from data.gov.sg and OneMap. They could access over 8,700 datasets available from 60 government agencies to power their apps. Apps4SG was organised by the Infocomm Development Authority of Singapore (IDA), the Ministry of Finance and Singapore Land Authority (SLA).

The team's success was reported in The Straits Times, Lianhe Zaobao, Enterprise Innovation and MIS Asia.

The root of Route My Day's rise began with Dr Qin Zheng's frustration over current mobile mapping apps not allowing for more than one activity to be routed. He sought to create one that could allow multiple activities to be mapped out.

Qin Zheng said: "We started the app development last year and a few members joined in the middle of 2013."

It was developed by a team of researchers from Computing Science (CS) Department, led by Qin Zheng. The team members include Dr Rick Goh, Dr Duan Rubing, Dr Wang Wenqiang, Kevin Veragoo, Jimmy Ong, Xin Xin, and Low Bingjiang. The team came about because of the strong support from CS Department Director, Dr Rick Goh.

Qin Zheng added: "I had approached Rick about my idea, and he was very supportive and gave me valuable advice on how to expand the project. As a result, it became an internal project, and it has become the key component of the Sustainable City Life Programme."

At the final round of the competition, the team was lauded by the panel of judges – including industry experts, venture capitalists and a media representative -- for its good usage of government geospatial data from OneMap.Sg to address a real need for mobile users.

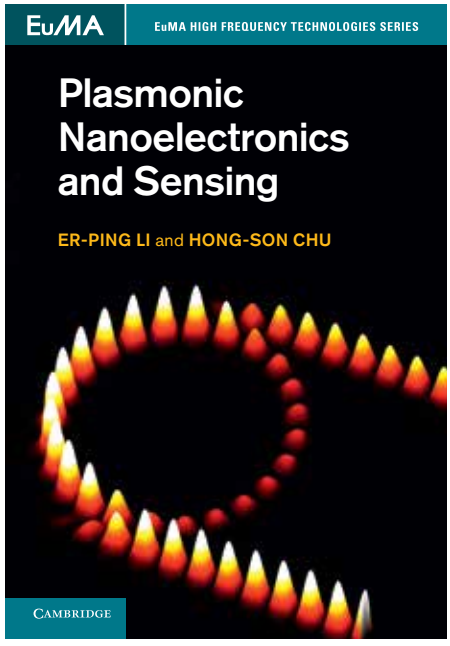
Ms Lim Soo Hoon, Permanent Secretary (Finance, Performance), Ministry of Finance, who was Guest-of-Honour at the Awards Ceremony, was impressed with a personal demo by the team.

"We are very excited about the win, and really appreciate the fantastic team support from IHPC colleagues. Winning the Second Prize at Apps4SG and receiving the positive comments from judges and the audience during the final round, have given the team the belief that we are heading the right direction."

The team is now in discussions with various agencies for potential projects which may use Route My Day's core technology to benefit people in Singapore.

"We would like to thank the support from the management of IHPC, which made it possible for the team to come so far! We are still developing and testing the app, and hope it can be used by the general public soon."

Writing The Book on Plasmonic Nanostructures



Dr Li Er Ping

Dr Chu Hong Son

There's a new book that promises to shed new light on plasmonic nanostructures. 'Plamonics Nanoelectronics and Sensing' was edited by Dr Li Erping, IHPC's Senior Director for Research Collaboration, and Dr Chu Hong Son from Electronics and Photonics Department.

Published by Cambridge University Press, the book was officially released in Feb 2014.

Plasmonic nanostructures provide new ways of manipulating the flow of light with nanostructures and nanoparticles exhibiting optical properties never before seen in the macro-world. Providing a comprehensive overview of the field, the book covers plasmonic technology from fundamental theories and numerical methods to real components and devices for nanoelectronic and sensing applications,.

Dr Li Er Ping said: "Nanoplasmonics is an emerging technology featuring both electromagnetic and optical theories and there are tremendous applications in nanomaterial based radio frequency (RF) engineering, nanoelectronics and sensing, and great efforts have been carried in our research group as well as sister A*STAR Research Institutes, which led to a series of scientific publications. We thought it should be summarized as an academic book for RF engineering, nanoelectronics and nanoplasmonics community."

In mid-2011, the Guest Editor of Microwave Book Series at Cambridge University Press, Prof Peter Russer, from the Technical University of Munich, Germany, had invited both researchers to contribute a book on RF(Radio Frequency) nanoelectronics, in view of their outstanding research in this field.

"Thereafter, we decided to publish the work based on our collective research in the past years."

It took almost two years of hard work to put the material together, and the experience gained was very valuable.

Dr Chu Hong Son added: "We learnt how to systematically construct the book's content with a series of materials, from fundamental theory, methodology, novel development, design and testing, and applications. We realized we had to ensure it had great readability to reach a wider audience, as a book is very different from a single scientific paper.

"Finally, we also learnt that teamwork and collaborative efforts were important in developing a book!"

The end result is a useful book for anyone interested in plasmonics R&D: Research scientists, postgraduate students, and engineers in computational modeling and simulation, and the larger microwave, nanoelectronics and nanoplasmonics community.

There are seven chapters in the book, contributed by different researchers from IHPC – present and past – including Dr Yuriy Akimov, Dr Liu Zhengtong, Dr Khoo Eng-Huat, Dr Wu Lin, Dr Bai Ping and Dr Iftikhar Ahmed.

There was also close collaboration with A*STAR colleagues from the Institute of Microelectronics (IME): Dr Zhu Shiyang, Dr Patrick Lo and Prof Kwong Dim-Lee, the Executive Director of IME.

The authors explained: "Part of the work was jointly conducted with IME colleagues. IHPC colleagues contributed the theoretical analysis while IME colleagues contributed to the device fabrication and testing sections. We had several discussions on how to put the work together as a unique book to reflect the entire theory as well as a real device and application.

"Prof Kwong gave us valuable advice and guidance on the book contents and the order of the chapters. Not only that, he also co-authored one chapter with his IME colleagues. We are very grateful to our IME friends for contributing to this book."

So, what advice do the two main authors have to share with younger researchers who are thinking about writing a book from scratch?

"Please be happy, persistent, patient and hardworking!"

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GrBEST team with Mr. Ang Kian Seng (center), Group Director (Research) of BCA

IHPC-BSD-BCA Joint Workshop on Green Building Environment Simulation Technology (GrBEST)

Dr Poh Hee Joo from Fluid Dynamics Department briefing the seminar participants on GrBEST.

Advances in Computational Fluid Dynamics (CFD) have enabled airflow simulation over urban landscape and building interior spaces to be conducted as a design optimization and assessment tool, helping architects to achieve effective natural ventilation of buildings even from the design stage.

Over the past year, IHPC has worked closely with two firms, Building System & Diagnostics (BSD) and RightViz Solutions, backed by the Building and Construction Authority (BCA) as the supporting organizer, to create an Airflow Modelling software application.

It is known as Green Building Environment Simulation Technology, or *GrBEST*.

This ground-breaking software has been developed to be a cost-effective and user-friendly CFD simulation tool for determining the airflow around buildings. The tool also allows for a quick modelling and simulation turnaround times. Future versions of *GrBEST* will also be used for BCA Green Mark natural ventilation simulation submissions.

GrBEST was publicly unveiled to the building and construction industry at a joint workshop conducted on 14 Mar 2014 at IHPC.

The event was attended by more than 30 practitioners, including architects, consulting engineers, and developers.

They came from various government agencies (BCA, HDB, DSTA & URA), institutions of higher learning (Temasek Polytechnic, Singapore Polytechnic, NUS, NTU & ETH) and building industry enterprises (Langdon & Seah Singapore, Bukit Sembawang Estates Limited, Ong & Ong, DCA, RSP, Surbana, BECA, and PB).

The event consisted of two sessions, beginning with a seminar which included a welcome address from the Executive Director of IHPC, Prof. Alfred Huan, and opening remarks from the Group Director (Research) of BCA Mr. Ang Kian Seng, as well as technology talks by Mr. Ken Po from BSD and Dr. Poh Hee Joo from IHPC.

The seminar was followed by a hands-on workshop using the GrBEST software application, which took place at the IHPC Training Room. The event was successful in garnering useful feedback from the participants and such insights will allow the Research team to enhance the future capabilities of this software.

At the end of the event, participants expressed their appreciation to IHPC for sharing the *GrBEST* presentation and modelling tool, and they looked forward to more workshops and further collaboration with the *GrBEST* development team.

IHPC's research and development work encourages the use of CFD simulation in building design and Green Mark certification. Hence, the development team aims to encourage the adoption of the *GrBEST* software by a wider audience, by motivating architects to implement good natural ventilation strategies at the building design stage. The end goal is to drive Singapore's construction industry towards the sustainable trend of more environmentally-friendly buildings.

GrBEST TEAM MEMBERS

IHPC:

Dr Poh Hee Joo (Principal Investigator)
Dr Bud Fox
Dr Nguyen Hoang Huy
Miss Petrina Tay Shu Hui
Mr Tay Meow Win

Partners:

BSD: Mr. Tan Phay Ping & Mr. Ken Po
RightViz: Dr. Chong Chiet Sing
BCA: Mr. Wong Ngian Chung,
Dr Gao Chun Ping, Ms Matilda Kenanga

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Making His Mak In Computational Chemistry

Dr Adrian Matthew Mak hails from the Interfaces team at IHPC's Materials Science and Engineering Department. He shares on what goes on in the mind of a computational chemist.

Q What led to you pursuing a career in scientific research?

A It's another one-thing-leads-to-another tale. I dreamt of being so many things as a child -- fighter pilot, doctor, teacher, even being an astronaut too!

As I grew up I realized that I liked numbers, computers and chemistry kits.

Truth be told, I didn't know computational chemistry was a scientific field, until I went to university. I guess it's a natural union of my interests that led me to one research project in university after another, and then graduate school, and now my career in scientific research.

Q How do you usually describe your work or research projects to friends and relatives?

A I tell them I do modelling and simulation of chemicals on the computer, sometimes using very powerful computers.

They are usually intrigued by the 'powerful computers' bit!

Q What does computational chemistry involve?

A Computational materials science spans many length scales. Matter can be studied at the very small scale (~10^{-11} to 10^{-10} m) where the behaviour of atoms and electrons has great influence over the properties of materials. The information from such studies can be used in a number of ways -- to improve on the computation methods themselves, or as parameters for large-scale methods, for instance.

The art of computational chemistry and materials science, coupled with powerful computers and software to model and simulate systems that have hitherto unknown properties helps us gain insight into understanding materials before they are even synthesized. This helps to save time and resources as well.

Part of my research interests lie in the development of novel electronic structure methods, using principles from numerical methods, physical chemistry and quantum mechanics, and the efficient implementation of such methods in software packages for computational chemistry, for use in the calculation and prediction of molecular properties.

Personally I find computational chemistry to be very useful to my colleagues in the wet lab (ICES and IMRE). Modelling and simulation results help them explain their experimental observations, and guide them in the design and synthesis of new chemicals and materials for various applications.

Q How is it like to work at A*STAR and IHPC?

A You're surrounded by smart people who come from all over the world. You share your knowledge with some, you learn from some. You cooperate and create stuff together. You work hard and push each other, and get pushed yourself.

Q What do you like most about your job?

A Sharing the knowledge that I gain and the science that I do with students, teachers, colleagues and friends.

I really enjoyed watching Bill Nye the science guy when I was growing up, and it is fun to do what he does once in a while.

Unlike many jobs that highly prioritize material and monetary reward, a career in science provides the intellectual challenge that is intrinsically rewarding to me.

What are your hobbies and personal interests?

Tinkering with computers, playing music, running, cooking, travel, crossword puzzles and video games, in no particular order.

But if I had to pick one favourite hobby, it would be crossword puzzles. Remember what I said about intellectual challenges?

It's a habit that I picked up while living in the States. I try to do one a day. It's addictive, and enriching.

(True story: We have spotted Adrian solving crossword puzzles while riding escalators.– Editor)

Q What serves as your motivation in your job?

A Curiosity. There's just too much of the world to discover in one lifetime. It is very humbling to discover that even as we learn more about our domain, you discover that there is so much, much more that we still don't know. And that drives me on.

My personal philosophy, in my job and in my life, is 'Be the change you wish to see in the world'.

(Note: This quote has been popularly attributed to Mahatma Gandhi, but it has not been officially verified – Editor).

Q What's a particularly memorable moments in your career with A*STAR?

A I don't have moments that were particularly memorable, truthfully speaking. If there was one, I suppose it was at IHPC's annual dinner last year. It was all home-brewed, and instead of an events company propelling the entire event, we had our own researchers and staff (including our executive director) entertaining us with their musical and dance talents. And they were brilliant!

It was heartwarming to be part of that IHPC event.

Q What's your take on Singapore's R&D sector?

A I feel cautiously optimistic. We have certainly made some good strides in stem cell research, bioengineering, infocomm technology, etc. We have our infrastructure in place, six universities, and encouragement from the government. We need young people who have a thirst for creating new stuff to make life better, to think different from the crowd and not ape a success story. We then need time for reactions to take place, to get us to the next stage of progress.

Q How does it feel to be a first time father?

A It's extremely tiring, but also fulfilling and meaningful to have a little one to look after. My baby boy is turning eight months old and he's quite a handful. My hope for him is that he grows up to be a happy and good person. And maybe, just maybe, he can be a sportsman like the daddy!

(Note: Adrian was a was a competitive swimmer in his high school days. His pet event was the 200m freestyle. Yes, we found it unbelievable too! – Editor)

Or if I can convince the wife, he might just take up martial arts.

Q How has receiving an A*STAR scholarship benefitted you?

A Well, the A*STAR scholarship helped me out financially, as it allowed me to pursue my PhD at NUS, and then two years of post-doctoral studies at the University of California, Berkeley, in the U.S.

But more than that, I am thankful for the support from the scholarship people that helped me through my studies, as they assisted me with the administrative affairs.

I am also thankful for the network of friends who took up A*STAR Graduate Scholarship at the same time as me. These folks offered great support and fellowship, and I'm proud to have them as friends for life.

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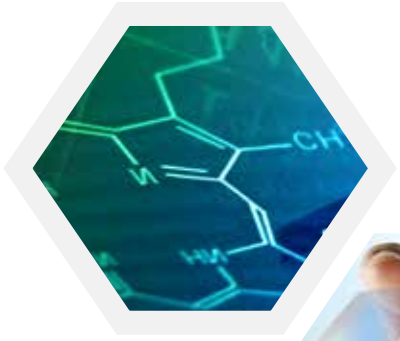

GRAPHENE goes where the sun shines

A team of researchers from the Electronics & Photonics Department discovers that graphene can potentially outperform ITO in terms of optical absorption.

The conventional transparent conductors frequently used in the touch screens of smartphones, laptops and thin film solar cells typically require high transparency of more than 90%, and electrical sheet resistance of less than 30Ω/□.

Indium tin oxide (ITO) is one of the few thin film materials which fulfil these requirements and is the most commonly used transparent conductor. In addition to the required optical and electrical characteristics, ITO also has high thermal stability and is able to operate with little variations over a huge range of temperatures.

However, ITO is mechanically brittle and is not suitable for flexible electronics.

In addition, indium, being a key rare earth element is becoming increasingly expensive -- due to its limited supply globally.

Enter Graphene, a novel two-dimensional material that has been shown to exhibit all the desirable properties of a transparent conductor.

(Graphene is, in essence, a one-layer thick arrangement of carbon atoms bonded together in a repeating pattern of hexagons. It is considered two-dimensional for a practical reason: It is one-atom thick and a million times thinner than paper.)

In addition to an optical transparency of more than 97% and a sheet resistance of ~120Ω/□ for monolayer doped graphene, the material also exhibits excellent thermal stability and flexibility.

Thus, graphene has been touted as the ideal transparent for flexible electronics such as OLED (organic light emitting diodes) and thin film solar cells. However, in terms of industrial applications, grapheme deployment has been evasive as the large scale production of large-area graphene is essential to trigger industry adoption.

The breakthrough in large-scale graphene processing came when the seminal Nature Nanotechnology Letter, 'Large-scale pattern growth of graphene films for stretchable transparent electrodes', was published in 2009. It demonstrated a roll-to-roll manufacturing technology for a large area chemical vapour-deposited graphene cover that was 30 inches in width.

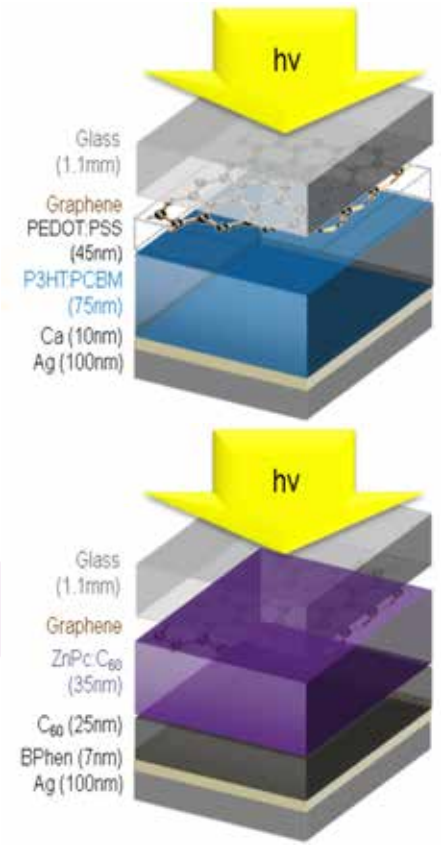

Fig 1. Schematic drawings of P3HT:PCBM and ZnPc:C60 organic solar cells

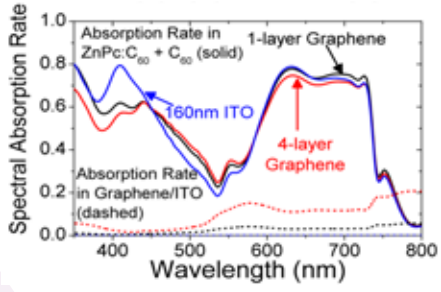

Fig 2. Spectral absorption rate of ZnPc:C60 device with 160nm thick ITO, mono- and four-layer graphene

This breakthrough illustrated that large scale graphene film production is now possible, and the use of graphene in consumer products to replace ITO is within sight.

An obvious application of graphene in scientific literature is to replace ITO in organic solar cells as evident by many studies of single and multilayer graphene in organic solar cells. The experimental comparison of the graphene devices with the ITO devices always show that graphene is unable to match the performance of ITO in both polymer and small-molecule organic solar cells.

A Contrarian View

This observation triggered the obvious question for this research team: Does graphene have the potential to replace ITO in organic solar cells?

We actually started with a contrarian view to the community, where most researchers think that graphene is potentially abundant material which can replace ITO.

This is because we noticed that graphene has a much higher sheet resistance as compared to ITO (i.e. 120Ω/□ vs 30Ω/□) and multi-layer graphene is required to reduce the sheet resistance to that comparable to ITO.

Intrinsic graphene has shown that every additional layer of graphene reduces the transparency by 2.3% and four-layer graphene (with an experimentally measured sheet resistance of ~30Ω/□ as required practically) reduces its advantage in optical transparency to ~90%, which is usually slightly lesser than ITO.

To confirm our contrarian view, we performed the simulations using our in-house transfer matrix code which solves for the transmission, reflection and absorption of two typical organic solar cells (polymer and small-molecule).

The polymer organic solar cell considered is the typical poly-3-hexyl thiophene : phenyl-C61-butyric acid methyl ester (P3HT:PCBM) bulk heterojunction device which absorbs in the wavelength spectrum from 350-650nm. It is not surprising to find that even after optimizing the thickness of the active layer (P3HT:PCBM), the performance of the graphene (as the transparent conductor) device is 92% that of an ITO device for normally incident light.

A similar behaviour is also observed for the Zinc-Phtalocyanine (ZnPc) : C60 organic solar cell which has a broader absorption spectrum of 350- 750nm. Interestingly, the performance of the graphene (as the transparent conductor) device is 98% that of an ITO device for normally incident light.

A closer look at the spectral absorption rate of the P3HT:PCBM and ZnPc:C60 active layers tells us that ITO enhances absorption through the interference effect as it is non-absorbing in the wavelength of interest. However, graphene basically allows light to pass through because it is optically thin and the increase from monolayer to four-layer graphene increases absorption in graphene substantially (compare black and red dashed lines in Fig 2). Thus, graphene seems to perform better (as a transparent conductor) as compared to ITO. This is due to the fact that interference enhancement by ITO is predominantly narrow-band and broadband transmission is much more important when the absorption spectrum of the active layer extends beyond 350-750nm.

Therefore, we have shown that we are right that graphene (where at least four layers are required to give similar sheet resistance to ITO) is not a good replacement as it is unable to outperform ITO for the typical organic solar cell (i.e. P3HT:PCBM and ZnPc:C60) when the absorption spectrum if the active material only spans between 350-750nm. However, the trend of our study also shows that graphene can potentially outperform ITO -- if the absorption spectrum of the active material in the organic solar cell extends beyond 350-750nm.

The state-of-the art organic active material (with record 8.9% efficiency and an absorption spectrum of up to 850nm) is expected to outperform existing ones, if four-layer graphene is incorporated as the transparent electrode instead of ITO.

In this study, we have demontsrated that four-layer graphene offers more than 90% of the performance in terms of optical absorption as compared to ITO transparent conductor for typical organic solar cells. We also note that the same four-layer graphene can potentially outperform ITO, if the absorption spectrum of the state-of-the art organic absorber is extended to 850nm.

(This article is an abridged version of the research paper titled 'The potential of graphene as an ITO replacement in organic solar cells: An optical perspective' written by a team that includes scientists from IHPC's Electronics and Photonics Department: Dr Koh Wee Shing, Dr Yuriy Akimov, Dr Bai Ping and Phua Wee Kee).

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HPC Trend Highlights

*The entrance to the NREL data centre. This visit comprises the team from Singapore (i.e. A*STAR, NTU, NUS) plus a few other centres from Asia.*

Professor Satoshi Matsuoka compared the various Green500 systems during his talk.

A visit to Supercomputing 2013 and the National Renewable Energy Laboratory (NREL) in Colorado, and a talk by Professor Satoshi Matsuoka from Tokyo Institute of Technology, provide some hints of the future of high performance computing.

SC13 and Visit to National Renewable Energy Laboratory (NREL)

A*CRC staff, accompanied by representatives from the National University of Singapore (NUS) and Nanyang Technological University (NTU), attended the International Conference for **Supercomputing 2013** (SC13) from 17 to 21 November last year.

The focus was to explore the newest technical offerings in the top tier High Performance Computing industry. Key observations from the show floor:

- There are **forty** installed supercomputers with **more than 1 PFLOPS Peak computing power** globally.
- China plans to build **two 100 PFLOPS** systems by 2015.
- The dominant players in this market are: IBM, Cray, HP, Fujitsu, SGI with some very interesting products from Eurotech and NEC. The strongest differentiators among industry offerings are: **warm water cooling, system integration, proprietary interconnects** more efficient than InfiniBand fat-tree topology interconnect, and well-developed software tools.
- The biggest institutional supercomputing player is the US Department of Energy.

The delegation also visited National Renewable Energy Laboratory (NREL) in Denver on 19 Nov. The host was Dr Steven W. Hammond, the director of NREL's Computation Science Center, who gave a tour of its HPC facilities.

NREL is the U.S. Department of Energy's primary national laboratory for renewable energy and energy efficiency R&D. The research is focused on the reuse of energy, and harvesting energy from new sources which are not invasive to the ecosystem.

RedMesa, NREL's current main HPC system has more than 15,000 Intel Xeon 5570 "Nehalem" cores with peak performance of 180 teraflops. It is co-located with the larger RedSky HPC system at the Department of Energy's Sandia National Laboratories.

RedRock is a 15 teraflops cluster with the same architecture and software stack as the full-production RedMesa system. By maintaining this cluster on-site, the Center can fully and rapidly test and profile new system modifications, software tools, and workflows before full-scale deployment on RedMesa.

Peregrine is NREL's warm water-cooled HPC system by HP, now being built in its Energy Systems Integration Facility (ESIF). Upon completion, it will have 1440 nodes with 6912 Intel Xeon E5-2670 "SandyBridge" cores and 24192 next-generation Intel Xeon "Ivy Bridge" cores, plus an additional 576 Intel Phi Intel Many Integrated Core (MIC) core co-processors with 60 cores each. The peak performance will be approximately 1.19 petaflops.

The heat produced by the system is used for heating NREL's facilities. It introduces a fairly novel approach to job scheduling, which takes into account how much heat is going to be produced, so that particular jobs can be run to deliver the desired temperature depending on the time of day and weather conditions.

The Tsubame2 Supercomputer & Big Data Seminar

Professor Satoshi Matsuoka from Global Scientific Information & Computing Center, Tokyo Institute of Technology presented a seminar on The Tsubame2 Supercomputer & Big Data on 28 Jan.

He highlighted that Supercomputers often stress their FLOPS as their primary benefit. While true in a classical sense, there is a growing need for very fast I/O capabilities in handling large quantities of data, namely, "Big Data".

Many observers believe that current-day cloud infrastructures are more suitable for big data processing compared to supercomputers, but such is simply not true considering technologies today and future technological trend trajectories.

Tsubame2.0, Tokyo Tech.'s petascale supercomputer, is touted often for its FLOPS and 'greenness', but it is likely also the world's first supercomputer to facilitate fast I/O for both resilience and big data processing. Currently, various research activities are being conducted to further enhance these properties, such that Tsubame2.5, a 6 petaflop update to Tsubame 2.0 in mid-2013, and Tsubame3.0, a 25 petaflop machine being planned for late 2015, would be considered as "big data supercomputers".

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Science Fiction With Winning Imagination

Winners and finalists of the Science Chronicles 2013.

A bumper crop of finalists and deserving winners materialised at the IHPC Science Chronicles Awards Ceremony.

It was full house at the National Library's scenic Pod facility at Bras Basah, as teachers, families and friends came to support the young writers at the awards ceremony on 22 February 2014.

Since 2008, the Science Chronicles competition has continued to inspire a new generation of scientific thinkers and writers who let their imagination reign free when it comes to the infinite potential of science and technology.

Our Science Chronicles judges had a hard time picking out the deserving candidates among the dozens of entries from 20 secondary schools and junior colleges. A total of 34 student writers were awarded with prizes and certificates for their outstanding efforts. Their stories will be published in the Science Chronicles 2013 volume, which will be distributed to all schools and public libraries by mid 2014.

Deputy Executive Director of IHPC, Dr Terence Hung, gave away the prizes, which included book vouchers, to the winners and finalists. Director of Corporate Services Sharon Ee, and Director of Electronics and Photonics Department, Dr Jason Png, were on hand to interact with the participants.

Nicholas Lim from Zhao Wei Films, represented Singaporean filmmaker Eric Khoo, who was one of the external judges for the competition who was not able to join the ceremony. Nicholas commended the quality of the stories that were submitted, and remarked Eric and him both saw great potential in the young writers and their creative ideas that might one day leap from printed page to the big screen.

Dr Bharathi Madurai Srinivasan from Materials Science and Engineering Department, also shared her perspective, both as a Science Chronicles judge with a passion for Science Fiction, and as an IHPC researcher concerned about the correct portrayal of scientific principles and concepts. She encouraged the students to think more deeply about science and technology, and how they can help to benefit society.

Heartiest congratulations once again to all the winners and finalists!

Participants listening to an address from Dr Terence Hung at the Science Chronicles Awards Ceremony.

Dr Terence Hung congratulated the winners, and commended on the collaborative spirit among writers for the 2013 competition.

OUTREACH

For students keen to participate in the 2014 Science Chronicles, be sure to check out www.science-chronicles.com for the latest updates.

We look forward to another exciting crop of imaginative science fiction stories that showcase the creative talents of the next generation of young writers!

A Big Thank You!

Just like at every Awards show, we cannot get away without thanking the important people behind the scene. IHPC thanks the external judges for the 2013 Science Chronicles for their gracious help: Ms Raneetha Rajaratnam from the National Library Board, and Mr Eric Khoo from Zhao Wei Films.

Many thanks to our internal judges as well:

- Dr Amy Khoo Khoong Hong (MSE)
- Dr Bharathi Madurai Srinivasan (EM)
- Ms Lee Hui Min (EP)
- Ms Lim Songlen Geraldine (MSE)
- Mr Phua Wee Kee (EP)
- Dr Ramanarayan Hariharaputran (MSE)

We would also like to thank IHPC management, including Executive Director Prof Alfred Huan, for their strong support, as always.

Finally, IHPC thanks the National Library Board for supporting the Science Chronicles Awards Ceremony again.

Results of Science Chronicles 2013

Position	Category A (Upper Sec Level)	Category B (Tertiary Level)
1st Prize	"Repetition" *By Joel Tan & Phyllis Poh* NUS High School of Mathematics and Science	"Prime Humanity" *By Nur'Ain Zainal* Anglo-Chinese Junior College
2nd Prize	"The Blue Kind" *By Faith Kok* Nanyang Girls' High School	"A Price of Progress" *By Tan An Yan* Raffles Institution
3rd Prize	"The Billionaire Club" *By Saayujya Chinmoy* NUS High School of Mathematics and Science	"Happiness 2030" *By Cherlyn Lee* Hwa Chong Institution and "Rebel" *By Wong Jo Yi* Anglo-Chinese Junior College

Joel Tan, 1st prize winner in Category A on his story, 'Repetition', written in collaboration with schoolmate, Phyllis Poh:

Nur'Ain Zainal, 1st prize winner in Category B on her story, Prime Humanity:

"After reading the Science Chronicles books, I realised that there were many stories along the lines of robots becoming sentient and clones becoming rebellious. I figured that writing such stories would be rather cliché but I really liked these ideas. So instead of writing about robots or clones, I decided to hook on to the concept of stem cells (something I was in the midst of studying while writing this) and I thought, what if instead of just organs, we could print an entire human being using 3D printing technology? After that, the whole Chernobyl and Fukushima situation came as a spark of inspiration and everything unfolded from there."

"The idea for my story was very much inspired by an idea to take science fiction in a different direction from the typical view on what it was. I wanted my story to be more subtle, focusing on the concept of humanity rather than an independent development of science. This decision led me to my story, which minimises the technicality of world building and the actual science involved, and instead focuses on the duration of time, how it can change a person, and the effects of genetic engineering on the concept of humanity as a whole."

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