CENTER FOR RELIABILITY SCIENCES AND TECHNOLGIES

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Inside this issue

PRESENTATIONS

22nd November 2019
International Smart Biomedical Industry Alliance technical seminar, Chang Gung, University, Taiwan

The GLORIA of Chang Gung University and the Taiwan Electronic Equipment Industry Association, which has more than 400 corporate members, jointly organized the technology sharing conference of international smart biomedical industry alliance in Chang Gung University. A total of more than 16 manufacturers were dispatched to the school for technical exchanges on the day, including a number of listed companies such as AU Optronics, Innolux, HIWIN mikrosystem, Foxsemicon Integrated Technology, and Gallant Precision Machining. This seminar invited experts from industry, academia and research including CGU's internal expert, Prof. C.M. Tan (Front 3rd Left), to share how to use reliability analysis to effectively reduce the cost of maintenance for equipment. Prof. Tan delivered a speech on "Reliability for electronics and systems". His talk includes fundamentals of reliability and various reliability evaluation methods used for assessing reliability of machine parts.

He also mentioned the importance of Root Cause Based Maintenance (RCBM) strategy which is employed by their group for reducing the cost of maintenance. Optimization of the maintenance schedules using Genetic Algorithm results in improving the operational availability and cost saving of about 60% of the current practice.

Later on, they also visited the center and were impressed by the work the center is doing.

28th – 31st January, 2020
CReST Director visits Deen Dayal Upadhyaya College, University of Delhi, India

Director of CReST, Prof Tan was invited to the Department of Electronics, Deen Dayal Upadhyaya (DDU) College, University of Delhi, India from 28th – 31st January, 2020. He had a meeting with the Principal of the college along with the Professors from Deen Dayal Upadhyaya college. He also presented a talk to all the students and faculty members for a Lecture series organized by DDU, Delhi. Prof Tan discussed about the reliability issues in the present industry and its causes and solutions. Title of his talk was “Welcome to the World of Reliability” where he shared his experience of reliability issues tackled by the modern-day industry and the ways to deal with them. He also held meetings with the other Professors of University and visited their labs.

28th January, 2020
Prof Cher Ming Tan delivers IEEE Distinguished Lecture Talk at University of Delhi South Campus, New Delhi

CReST Director, Prof Cher Ming Tan presented a talk at Department of Electronic Sciences, University of Delhi South Campus, New Delhi, India organized by IEEE Electron device society (IEEE-EDS). The title of the task was "Computational Reliability – A paradigm shift in product reliability assurance". The talk was appreciated and attended by about 60 audiences, these were Professors, research scholars, Graduate and undergraduate students from Delhi and its surrounding areas.

Abstract: Product reliability is increasingly important as we rely on technology more and more. However, current reliability method can provide product reliability assurance only after the products are manufactured, and if they do not pass the requirement, re-design and re-test will be needed. This will cause a time delay and incur significant cost. In today competitive market, and the complexity of the products, the current reliability method is running out of stream. This talk presents a computational method where product reliability can be computed even before it is fabricated. Thus, the product reliability assurance can be ascertained only it is manufactured.

RECENT PUBLICATIONS

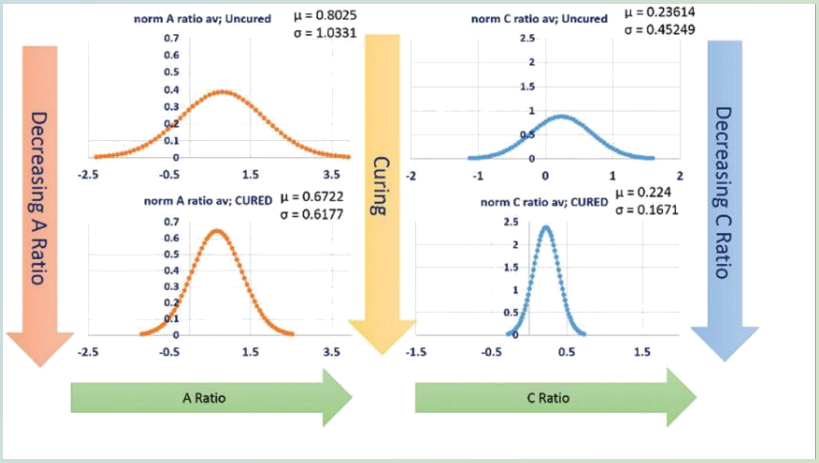
Recent publications

The list of recent publications made by the members of Crest is in the quarter from Oct to Dec;

1. **Moisture resistance evaluation on single electronic package moulding compound**

   -Tan, Cher Ming, et al. "Moisture resistance evaluation on single electronic package moulding compound." *Journal of Materials Chemistry C* (2020). (Impact Factor: 6.641)- Also included as a cover page for the journal.

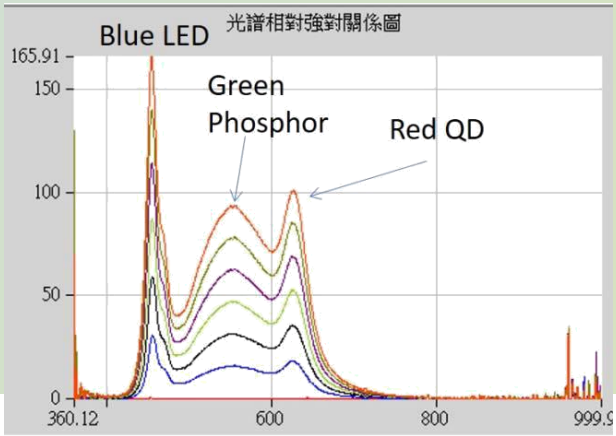
Non-destructive evaluation indices that correlate with the moisture resistance of integrated circuit packages are developed. These indices are developed from detailed studies on the functional groups in a molding compound, and their effectiveness is verified experimentally. With these indices, one can ensure the moisture resistance of an individual package without the need of the standard humidity tests which require long test durations on limited number of samples where extrapolation with statistical uncertainty will be present.



2. **Dependence of operating conditions on lifetime of Phosphor Quantum dots-based white LEDs**

   - Singh, Preetpal, et al. "Dependence of operating conditions on lifetime of Phosphor Quantum dots-based white LEDs." *2019 IEEE 9th International Nanoelectronics Conferences (INEC)*. IEEE, 2019.

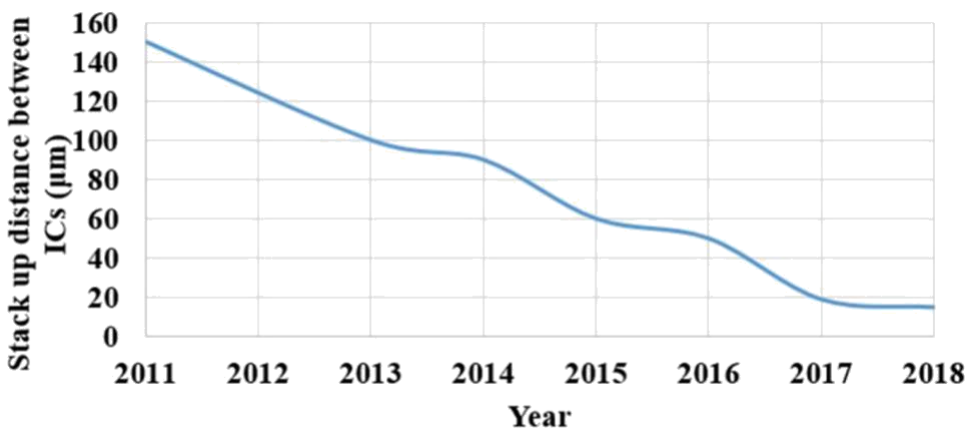
Lifetime of packaged Phosphor- Quantum dot (QDs) based white LEDs is studied. Various stress parameters such as blue light luminance, temperature and moisture are considered and their effect on the performance of the Phosphor-QD based LED is investigated. The lumen degradation rate and degradation trend for LEDs is observed to be different under varying stress conditions. Lumen recovery process is also observed under light stress test**.**



3. Evaluation of the Potential Electromagnetic Interference in Vertically Stacked 3D Integrated Circuits

- Kapoor, Dipesh, Cher Ming Tan, and Vivek Sangwan. "Evaluation of the Potential Electromagnetic Interference in Vertically Stacked 3D Integrated Circuits." *Applied Sciences* 10.3 (2020): 748. (Impact Factor: 2.217)

Advancements in the functionalities and operating frequencies of integrated circuits (IC) have led to the necessity of measuring their electromagnetic Interference (EMI). Three-dimensional integrated circuit (3D-IC) represents the current advancements for multi-functionalities, high speed, high performance, and low-power IC technology. While the thermal challenges of 3D-IC have been studied extensively, the influence of EMI among the stacked dies has not been investigated. With the decreasing spacing between the stacked dies, this EMI can become more severe. This work demonstrates the potential of EMI within a 3D-IC numerically, and determines the minimum distance between stack dies to reduce the impact of EMI from one another before they are fabricated. The limitations of using near field measurement for the EMI study in stacked dies 3D-IC are also illustrated.



4. In-situ Characterization of the Defect Density in Reduced Graphene Oxide under Electrical Stress Using Fluorescence Microscopy

- Zequn Zeng, Preetpal Singh, Sharon Lim Xiaodai, Cher Ming Tan and Chorng Haur Sow. “In-situ Characterization of the Defect Density in Reduced Graphene Oxide under Electrical Stress Using Fluorescence Microscopy” *International Journal of Nanotechnology. To be published.*

A new approach to characterize the defect density in graphene oxide (GO) is presented in this work. Fluorescence microscopy is employed to directly observe changes in defect density on the graphene oxide surface at the macroscopic level. The area under scan becomes darker as the electrical bias is increased from 0.5 V to 3 V. Gray level conversion of the fluorescence images are used to quantify our results. The reduction of graphene oxide as observed under fluorescence microscopy images is also verified using Raman microscopy where I_D/I_G ratio decreases as the voltage stress is increased. However, defect density increases for the samples from 0 to 0.5 V range and are maintained till 1 V, which shows that this range may not be suitable for electronic applications when graphene oxide is employed as its electronic properties are poor in this range. Thus, this *in-situ* measurement of defect density on the graphene oxide for large area graphene samples can help in identifying the uniformity of the defect density on GO as well as its defect density changes under electrical bias condition, an information crucial for its electronic applications.

AWARDS

Dr. Vivek Sangwan Receives Best Presenter Award at TESDC-2019

In order to enhance the research and development capabilities of Electrostatic Discharge (ESD) protection technology and reliability technology, the Taiwan ESD Association (T-ESDA) invited all sectors to publish ESD and Reliability related technologies Research experience, jointly discuss countermeasures to solve ESD and Reliability problems. At the seminar, in addition to the research results of related technologies published by domestic parties, all participants also conducted intensive technical exchanges and found possible solutions to professional problems during the seminar.

Dr. Vivek presented his work entitled “Failure Mechanisms of GaN Transistors in High Power Integrated Circuits”, and his presentation was elected as the TESDC-2019 Best Presentation.

The paper list is announced at: http://www.alab.ee.nctu.edu.tw/~esd/TESDC/

The certificate is awarded and a reward of NTD 5000 is given to the presenter.

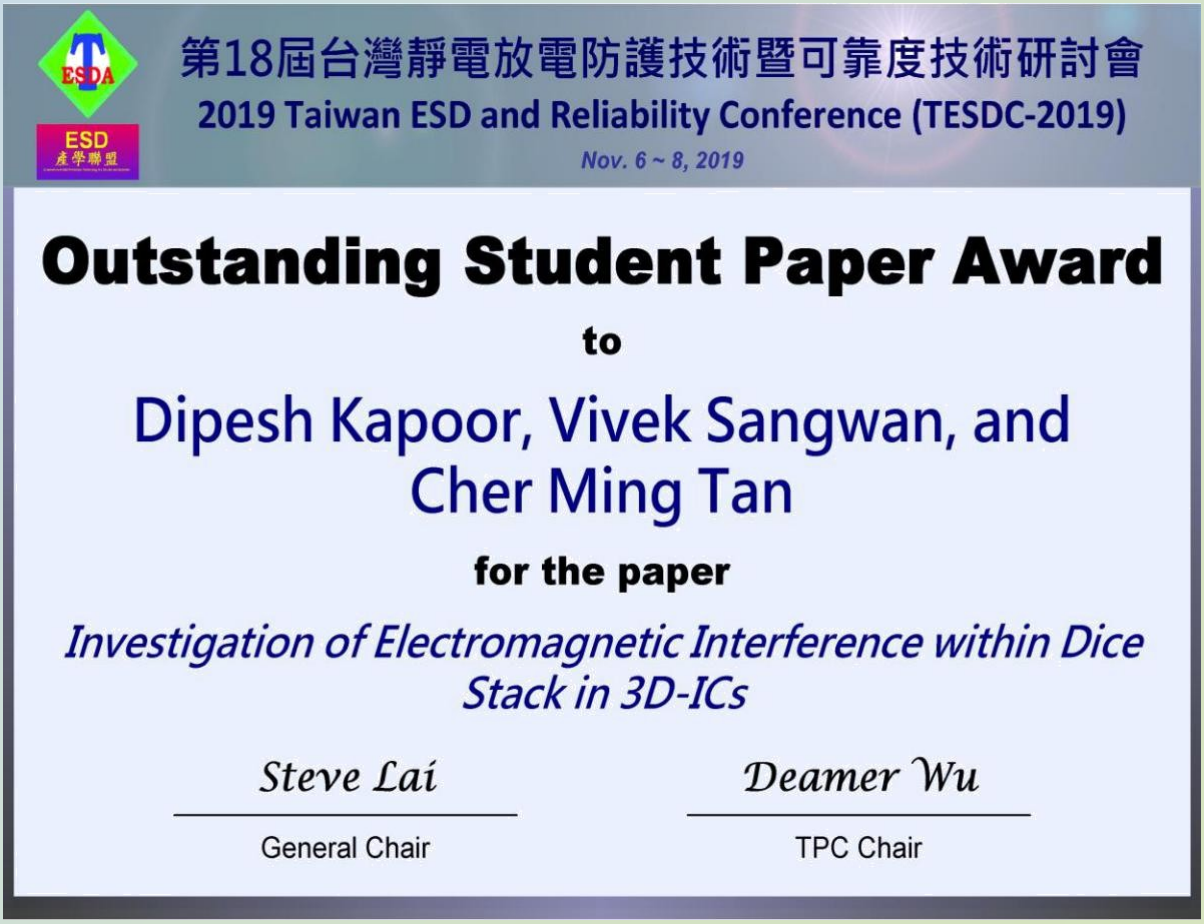
CReST Team Receives Outstanding Student Paper Award at TESDC-2019

In order to enhance the research and development capabilities of Electrostatic Discharge (ESD)
protection technology and reliability technology, the Taiwan ESD Association (T-ESDA) invited all sectors to publish ESD and Reliability related technologies Research experience, jointly discuss countermeasures to solve ESD and Reliability problems. At the seminar, in addition to the research results of related technologies published by domestic parties, all participants also conducted intensive technical exchanges and found possible solutions to professional problems during the seminar.

CReST Team, comprising Dipesh Kapoor, Dr. Vivek Sangwan and Prof Cher Ming Tan presented their work entitled “Investigation of Electromagnetic Interference within Dice Stack in 3D-ICs”, and this work was elected as the TESDC-2019 Outstanding Student Paper.

The paper list is announced at: http://www.alab.ee.nctu.edu.tw/~esd/TESDC/

The certificate is awarded to team, and a reward of NTD 3000 is also given to the corresponding author (student).



VISITS

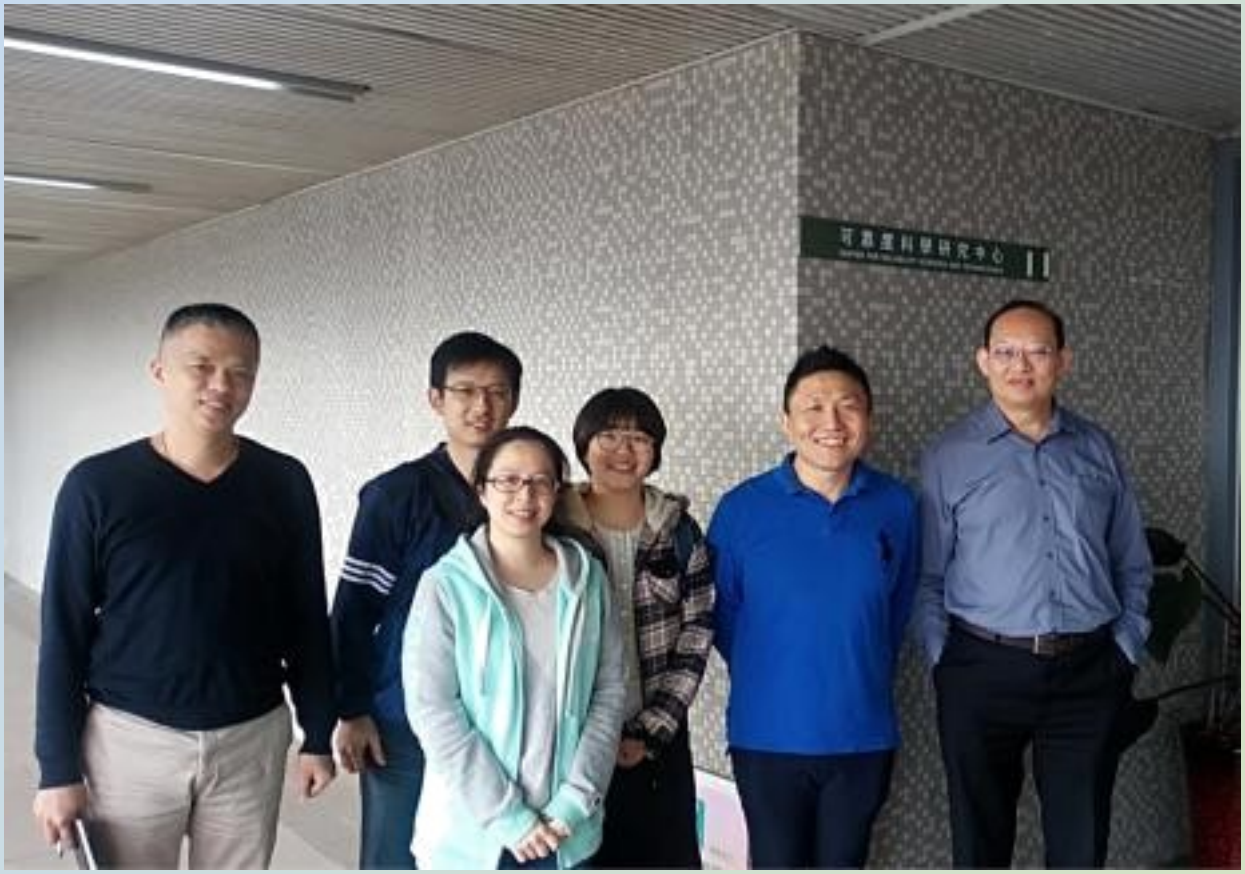
5th December, 2019
Future Tech 2019, Taipei visit by CReST lab members

Future Tech 2019 has been renamed into Futex Taipei 2019 with the emphasis on future technology. Exhibition has amassed an array of leading academic scholars and mind-thinkers who are taking Futex Taipei 2019 to a whole new level. They have created cutting edge products and innovations to move the country forward into the future and continue to keep Taiwan as the leading innovator in all tech-related fields. These fields include Medical and Biotech Innovations, Smart Machinery and Evolutionary Materials, AI and Electronic Innovations, and Green Energy and Environment. Prof Cher Ming Tan visited the exhibition accompanied by CReST Lab members, Dr. Preetpal Singh, Dr. Sandeep Sharma, Vimal Pandey, Dr. Vivek Sangwan and Dipesh Kapoor. They visited various booths of the exhibition demonstrating their expertise and innovating ideas or products. Young researchers from all the research centers in Taiwan visited this exhibition and the products or ideas ranges from bio-medical, agriculture, bio-informatics, opto-electronics, embedded designs, nano-electronics, etc.

24th December, 2019
Visit Nanya Plastic Cooperation

Prof Tan Cher Ming visited Nanya Plastic Cooperation (Formosa Plastic Group), Miaoli, Taiwan to discuss the development of Predictive maintenance strategy for multi-stage compressor for their plant. A strategy is designed to predict the lifetime of various parts of their components and their compressor's overall lifetime. Prof Cher Ming Tan along with Dr. Loganathan discussed the project details and the future work for the project.

9th January, 2020
MOXA visits CReST lab



CReST Lab had witnessed the visit of a Global automation company MOXA. They develop reliable network solutions that enable devices to connect, communicate, and collaborate with systems, processes, and people. Their customers are over the global, and it is a Taiwan-based multi-national company. This visit was to explore collaborative work between MOXA and CReST lab in the future. As a reliability expert, Prof Tan and his team will help MOXA in improving their product reliability and develop smarter ways to deal automation processes.

12th January, 2020
Taiwan Semiconductor Manufacturing Company (TSMC) visits CReST lab

The world's largest semiconductor foundry, manufacturing 10,436 different products using 261 distinct technologies for 481 different customers, Taiwan Semiconductor Manufacturing Company (TSMC) visited CReST for the final report presentation after a year of collaboration with TSMC. Further collaboration is being planned.

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15th January, 2020
Prof Nan-Kuang Chen Visits CReST Lab

Prof Nan- Kuang Chen, from School of Physics Science and Information Technology, Liaocheng University, China, visited CReST on 15th January, 2020. Prof Chen is an eminent scholar having authored and co-authored more than 230 international SCI journal and conference articles. He is the awardee of the Flexible Compensation Program to Recruit and Retain Special Outstanding and Talented Faculty (教育部獎勵特殊優秀學人彈性薪資方案), Ministry of Education, Taiwan from 2013-2015. He has been a reviewer for 49 prestigious SCI international journals, Research Grants Council, Hong Kong, and Ministry of Science and Technology, Taiwan. He has also served on the General Chair/Technical Program Chair/International Advisory Committee/Technical Program Committee/Organizing Committee and Session Chair for more than 90 times in many international conferences (including IEEE), delivered 40 invited talks and 1 keynote talk in international conferences (including IEEE Photonics North, OECC, CLEO-PR, ACP, and CIOP) and organized three international conferences (IAPTC 2011, IEEE/ICAIT 2013, and IEEE/ICICN 2019). He holds 14 ROC patents, 12 US patents, 1 Korea patent, and 4 PRC patents. His research interests include micro- and nano-fiber sensors, micro optical forces (Van der Walls force and evanescent attractive force) and its microsensing applications, dispersion engineering technique, Cr^{3+}-doped fiber amplifier, large core high power fiber lasers, and mode-locked femtosecond fiber lasers. Director of CReST, Prof Tan had a fruitful discussion with Prof Chen regarding the possibilities for future collaborative projects as well as their ongoing research works in respective areas.

NEW APPOINTMENTS

New Affiliations for Prof Tan Cher Ming

1. Director of CReST, Prof Cher Ming Tan is appointed as **committee member for IEEE-EDS Masters and PhD Student Fellowship Committee**. This committee will award prestige fellowships to outstanding master and Ph.D students in the world who are doing research within the Electron Devices Society's field of interest.

2. Prof Cher Ming Tan is also invited to serve as a **Member of the International Advisory Board of The Assam Kaziranga University, India.** The Assam Kaziranga University is a multidisciplinary University, established under the Assam Private University Act No. XII of 2007 under section 2(f) of UGC Act 1956 with the aim of providing quality education and research avenues relevant to the contemporary world.

3. Prof Cher Ming Tan is also appointed as a **Special Issue Editor** of MDPI Journal of ***Applied Sciences*** (ISSN 2076-3417, Impact factor: 2.217). This Special Issue focusses on various methods and examples to improve, evaluate, and predict the reliability of electrotechnical systems and devices that constitute smart systems and the smart world.

NEW MEMBERS

New members

The new research members joined Crest recently are;

1. **Dr. Preetpal Singh, PhD**

Dr Preetpal Singh has joined CReST on 20 November 2019. He received the B.S. degree from the Guru Nanak Engineering College, Hyderabad, India, in 2007, and the M.S. degree from Amity University, Noida, India, in 2013. He finished his Ph.D. degree with the Department of Electronic Engineering and the Semiconductor Laboratory, Chang Gung University, Taoyuan, Taiwan. His research interests include graphene-based high power LEDs, high power LED degradation study, LED reliability, FEM based simulation, Li-ion battery degradation models and failure analysis. Crest welcomes Dr. Preetpal to join this vibrant research team.

2. **Abdul Shabir**

Abdul Shabir has joined on 30th Dec, 2019. Abdul Shabir received his M.sc in Physics from The Assam Kaziranga University, India. He is presently an intern at Crest under TEEP internship Program. His research focuses on MedeA VASP software working on DFT calculations. He will join CReST Lab as a PhD candidate from Feb, 2020.

3. **Smita Raut**

Smita Raut has joined on 11 December 2019. She is Studying in Final Year BTech Computer Science at Rajarambapu Institute of Technology Dist-Sangli, Maharashtra, India. Presently, she is under internship programme of TEEP at Crest. She is working on the GUI aspect of the software developed from the collaborative project between Formosa Company and CReST.

4. **Pooja V. Magdum**

Pooja V. Magdum has joined on 11 December 2019. She is Studying in Final Year BTech Electronics engineering at Rajarambapu Institute of Technology Dist-Sangli, Maharashtra, India. She has worked on projects in the VLSI domain. Presently, she is under internship programme of TEEP at Crest. and she is working on a project related to PCB design.

5. Lee Bai Song Samuel

Lee Bai Song Samuel has joined the CReST lab on 30th Dec 2019 as a research attachment under TEEP. Samuel received his B. Eng. in Engineering Product Development (Electrical) from the Singapore University of Technology and Design in 2015 and is currently pursuing his PhD in the same university. His research interest is in analog IC chip design and measurement of chip blocks such as transimpedance amplifiers. At CReST, Samuel will work on a project designing chips for radiation hardness for medical equipment using GaN technology.

6. Yash Jain

Yash is currently in final year pursuing B.Tech in Computer Science & Engineering from The Assam Kaziranga University, India. He joined CReST on 21st December, 2019 under TEEP Internship Program. Presently, his work includes GUI development, website development, software testing & bug fixing.

GRADUATION

Congratulation to Mr Chen Che being awarded Master of Engineering Degree

Che Chen (Brian), a Masters student of Crest, has successfully defended his thesis entitled*:* Semi-empirical mathematical model for rechargeable Li-ion battery cycle life , on 9th January 2020. Photo shows the defense committee for his Master Oral Defense.

After year of research and studies, Chen Che is finally awarded a master degree and a job is awaiting him outside.

The abstract of the thesis is appended below.

Due to its high energy density, long life and high efficiency, Li-ion battery has gained advantages in the market and continue to expand into other fields. Correspondingly, BMS (battery management system) is also become more important in acquiring rapid and accurate evaluation of the capacity and health of battery. This research proposes a semi-empirical fading model that is able to quickly assess battery health status and estimate its future degradation trends. The results presented herein include the maximum capacity and health state attenuation observed for LiBs during room temperature and high-temperature environmental testing until the sample degenerates to 80% State-of-Health (SoH) of the electric vehicle specification. In this work, the accuracy of this model will be verified by using different ambient temperatures and discharge currents as experimental parameters.

For the room temperature experiment, the semi-empirical model provides an accurate SoH estimation with a difference of less than 2.22% when compared with the ECBE calculation. The model parameters derived from a LiB cell can also be applied to other cells in the same series with less than 2.5% difference from complex ECBE model, showing the extendibility of the model.

When the ambient temperature rises, there is a rapid SoH degradation which is also a challenge for SoH evaluation. The maximum average error occurs at the most extreme discharge condition (55°C with 5 C-rate) is 5.48%, and the health of this sample drops to the cut-off threshold in around 120 cycles. Excluding the above extreme condition, the remaining test results show that estimation errors at 25°C are 2.45% and 2.52% at 1C and 3C respectively, and the overall error at 55°C is less than 1%. Thus, this model provides an accurate SoH estimation at extreme temperature conditions and at high C-rates, and the computation time and resources needed to perform SoH estimation using the proposed model is very low. These characteristics make this model very suitable for the real-time estimation which is also the conclusion of this research.

SOCIAL ACTIVITIES

CReST Lab Celebrates Annual Christmas celebration

All students, faculty, and staff gathered in CReST Lab conference room to celebrate the annual Christmas festival tree lighting on Thursday, 28 November 2019.
Prof Cher Ming Tan, Director of the Center said that it was a wonderful opportunity to come together as a faculty, staff, and students, to celebrate this Christmas season. He also shared the meaning behind Christmas celebration as members of the center belong to different religions.