SYMPOSIUM on
SOLDER INTERCONNECT RELIABILITY
8-11 December 2015
UTown, NUS, Singapore

Schematic and Micrograph of Advanced Interconnect Architecture

Organized by
NUS
National University of Singapore

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A-IATS
SSEEA

Please refer http://www.a-iats.com/ for new updates
Secretariat

The symposium is organized by NUS/Singapore, UMD/USA in association with A-IATS (Singapore) and SSEA. All correspondence should be addressed to:

**The Symposium Secretariat**
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National University of Singapore  
Email: phyrgk@nus.edu.sg

**Prof Michael Pecht**
Director, CALCE  
University of Maryland, USA

Technical Chair

**A/P Tok Eng Soon**
Department of Physics,  
National University of Singapore

Symposium/Exhibition Venue

The technical symposium, table top exhibition, and education courses will be held in 8-11 Dec 2015 appropriately in

**UTown Auditorium 1, Level 1, Town Plaza**  
National University of Singapore  
College Ave West, Singapore – 138607  
Solder/Microsolder Interconnect... Reliability Relevance

The enhanced reliability of solder-substrate interface in flexible, bendable, and wearable advanced electronic products is becoming a necessity with the inevitable integrated demands of Tsensors, IoT and eHealth.

Solder and lead-free solder Interconnects with tighter pitches, higher volumes, and lower costs have been a constant challenge for the micro bonding landscape.

In spite of the tremendous amount of R&D work on manufacturing issues associated with lead-free electronic packages and assemblies, by industry, national labs, consortia, and academia worldwide in the last decade, the reliability advancement of lead-free solder interconnects is still scientifically significant, industrially important, and socially relevant.

This inaugural symposium provides an overview of the technology trends, and development challenges in methods, materials and applications in the solder-joint engineering arena with special emphasis on upcoming technologies for electronic cluster industries.

The primary purpose of this symposium is to bring together the solder/surface engineering professionals, and end users from Asia and ASEAN for R&D and business collaboration opportunities in YOUR SINGAPORE.

Technology topics to be addressed include:

- Micro- structural evolution and interfacial interactions in lead-free solder interconnects (LFSI)
- Lead-free solder joint reliability status and trends
- Chemical interactions and reliability testing for LFSI
- Tin whisker growth on lead-free solder finishes
- Accelerated testing methodology for LFSI.
- Thermomechanical reliability prediction, DfR, FEM of LFSI.
- Characterization and failure analysis of lead-free solder defects.
- LFSI reliability outlook at micron landscape.
- Surface finishing/coating development
- Surface finish at PCB and chip bond
- Substrate pad finish (NiAu, OSP, SoP,ImSn, ENEPIG, nanocoat)
Technical Symposium

Keynote talk, invited presentations, poster contributions will be in 9-10 Dec 2015 from 0900am to 1730pm.
The abstracts are requested on or before 25th Nov 2015.

Education Courses

Solder interconnect reliability involves the integration of applied sciences and engineering and hence currently there is a need to groom engineers and researchers from various levels - technicians, graduate and postgraduates in multidisciplinary areas. The courses will be conducted at UTown, NUS from 0900am to 0530pm. They are

a) Solder and Solder – Surface Finish Reliability:
   - This topic will be conducted on Tuesday, 08 Dec 2015.

b) Practical Surface Engineering Process and Interface Analysis:
   - This topic will be conducted on Friday, 11 Dec 2015.

Table-Top Exhibition

An exhibition will be held in conjunction with the symposium in UTown, NUS at Singapore. It will be open on 9-10 Dec 2015 from 1000am to 1700pm to facilitate a communication channel between the users and manufacturers in solder – joint interconnect engineering technologies. Please contact the secretariat for exhibition participation and benefits.

Target Industries & Audience

Semiconductor, aero-space & disk drive component manufacturing industries, equipment builders, suppliers/makers of substrates, leadframes, passive components, bondwires, connectors, flux/mold compounds, assembly houses, electronic test centre, PCB manufacturers, and surface finishing sub-cons.

Technical officers, engineers, managers, R&D personnel, company CEOs, graduate students, polytechnic/JC lecturers and all those engaged in the electronic package @ assembly/surface finishing Industries at ASIA and ASEAN.
Poster Presentation and Award
Poster presentations by graduate students are strongly encouraged. The presenter of the respective poster are also given brief time to present their work in addition to poster display. Poster format are at the website. Two best posters by full-time students will be awarded by The Institute of Physics (IPS), Singapore.

Student Membership in SMTA/USA and SSEA/Singapore

University students are welcome to join the above mentioned industry-centric associations. The necessary forms and information will be available on 8-11 Dec 2015 at the symposium/exhibition venue.

Full-time NUS UG and PG student's membership have been waived for one year by SSEA and A-IATS. Please contact symposium secretariat for more details.

Learn more about these associations and their benefits from a) http://www.smta.org/, b) http://www.aseansurfin.org/.

Visits

Arrangements for visits to the key Research Centre at NUS (CIBA and SSL) are planned on 10 Dec 2015 from 1600hrs onwards.

Sponsorship

Opportunities are available to advertise your company products and services in souvenir booklet and exhibition area. Please contact symposium secretariat for more details.

Downloadable forms:

Registration form, modes of payment, abstract template guidelines, and poster format guidelines are available at http://www.a-iats.com/
Keynote on Wednesday, 9th Dec 2015

A Perspective of the IPC Report on Lead-free Electronics
- Prof Michael Pecht, Director/CALCE, UMD, USA

In April 2015, IPC published a report titled “Issues and Outlook for Lead-free Electronics in Military and Aerospace Applications.” This keynote will discuss and comment on the report in light of the current state of practice of lead-free usage in high-reliability applications. The keynote will also present challenges for exempted and excluded companies associated with cost increases, reduced access to emerging lead-free based technologies, the risk of counterfeit part infiltration, and the proliferation of “refurbished” parts in the supply chain.

Keynote on Thursday, 10th Dec 2015

A Focused Laser Beam: Useful Tool for Nanoscience Research
- Prof Sow Chorng Haur, Head of Physics Department, NUS, Singapore

Nanoscale materials have attracted great interests in recent years. Low dimensional such as nanoparticles, nanowires, nanorods, nanowalls, nanosheets, and nanojunctions or networks are an important category of nanostructured materials with great potential as important components for nanoscale devices with various interesting functions. Thus, in the past decade, many techniques have been developed for the synthesis of such nanostructured materials. In addition, researchers have put in great effort in the studies of hybrid nanomaterials. With these efforts, a wide variety of nanostructured materials have been investigated. These include carbon nanotubes, binary and ternary II-VI alloys, hierarchical metal oxide and etc. After the synthesis of the nanomaterials, it is desirable to be able to further modify the properties of the nanomaterials to improve the functionality of these nanomaterials. If we can create micro patterns on these as-grown nanomaterials, it will be able to further expand their potential applications. In recent years, efforts involve the alteration of physical and/or chemical properties of nanomaterials via the use of a focused laser beam have generated a lot of interests. In this presentation, we will present our efforts in the studies of hybrid nanomaterials with the emphasis on how the focused laser beam can be used as/for (a) Micro Manipulation Tool: Optical Tweezers, (b) Micro patterning and Micro structuring Tool, (c) Micro-Architecturing, (d) Micro-Photocurrent Studies, (e) Micro Photochemical Reaction (f) Micro light-House and (g) Micro-Actuating Tool.
Invited Talks (9-10 Dec 2015)

1. Remaining Issues with Pb-Free Electronics
   - Dr Michael Osterman, UMD, USA

2. Solder coated Copper Microspheres and Applications
   - Prof HT Yum, Korea Surfin Consultant Company, Korea

3. Solid-solution Strengthening in Lead Free Solder Solution
   - Mr Wayne Ng Chee Weng, Nihon Superior, Singapore

4. Dynamic Nanostructure Evolution and Evaluation by Advanced Analytical TEM
   - Prof Danel Chua, MSE, NUS, Singapore

5. Sputtering and Dry Etching Technique for Interposer to achieve High Density Wiring Mounting
   - Tetsushi Fujinaga, ISET, ULVAC, Inc., Japan

6. Thermal and Magnetic Properties of Nickel Particulates in SAC305 Solder
   - Dr S.W. Ong, Dr Gopala Krishnan and A/P Tok Eng Soon εMaGIC Laboratory, Department of Physics, NUS, Singapore

7. Fluxless Flip Chip bonding with SnAgCu
   - Dr Lee Teck Heng, Director, Technology Development Centre, Institute of Technical Education, Singapore

8. Fabrication and Evolution of Thin Film based GaN UV Photodetectors
   - Dr. L. Ravikiran and Prof. K. Radhakrishnan, EEE, NTU, Singapore

9. The Evaluation of Copper Migration during the Die Attach Curing and Second Wire Bonding Process
   - Dr Jisheng PAN, A*STAR, Singapore

10. Solder Interconnection: Strength, Weakness & Opportunities for next generation.
    - Mr. Ranjan Rajoo, Global Foundries, Singapore

11. A REACH-complied pure gold process for soldering/bonding applications
    - Priscilla Hong, Metalor, Singapore
Solder and Solder-Surface Finish Reliability:

1) Physics of Failure Based Reliability Practices
   - Dr Michael Osterman, UMD, USA

Reliability is the ability of a product to perform as intended (i.e., without failure and within specified performance limits) for a specified time, in its life cycle application environment. The physics-of-failure (PoF) approach to reliability utilizes knowledge of the life-cycle load profile, product architecture, and material properties to identify potential failure mechanisms and to reduce product failures through robust design, manufacturing, and product verification practices. Physics-of-failure based product realization methods incorporate reliability into the development process providing a scientific basis for estimating product life under life cycle conditions.

This course introduces the classical reliability concepts and relates the concepts to the physics of failure approach. The information provided in this course will be useful for implementing a physics-of-failure methodology for the life cycle of a product. The participants will learn how to develop and migrate to physics-of-failure based reliability assessment programs from current practices. The seminar will introduce the concept of physics of failure and its application in product development.

1. Introduction
2. Device Level Failure Models
3. Assembly Level Failure Mechanism and Models
   a. PWB Failures
   b. Solder Interconnects
4. PoF Simulation Assisted Reliability Assessment

2. Copper Clad Solder Ball (CCSB) Technology and Impact
   - Prof HT Yum, Korea Surfin Consultant Company.

Copper Clad Solder Ball (CCSB) has many advantages in advanced interconnect architecture such as good stand-off between packages, chip damage prevention and lower pad pitch. This novel and innovative conceptualization, undertaken at Korea Technology Co. and MKE Co on the development of electrolytic plating of the well-known SAC305 solder on copper balls sizing from 120 to 180 um in diameter will be presented and discussed.

3. Inductive Microheat-seed Development for Solder Bonding
   - Dr Gopala Krishnan, Yaadhav RAAJ* and A/P Tok Eng Soon
   - MaGIC Laboratory, Physics, NUS, Singapore
   - *A-IATS, Singapore.URL: www.a-iats.com
Low-frequency electromagnetic induction (EMI) based reflow oven process and magnetic-micro seed (MMS) dispersion are strategically gaining prominence in recent years through the foundational use of Ferromagnetic (FMM) based Sn-based solder system. This novel idea initiated by A-IATS(Singapore) on MAG-SOLDER development of FMM-SAC305/Cu-BGA solder joint from a cluster of process and analytical techniques such as low-temperature ball-milling, rapid thermal process (RTP), isothermal annealing, cross-section/line polishing, XRD, VSM, DSC and SEM-EDX/BSE are compiled and discussed for EMI-centric reflow oven development and deployment.

4) Statistical Analysis of Reliability Test Data
- Prof Tan Cher Ming, Chang Gung University, Taiwan

Reliability is crucial to the success of product sales in today competitive market. Reliability test is now a common routine to most of the manufacturing. However, the analysis of reliability test data is not straightforward since it involves advanced statistics. Although there are many existence software available for the reliability data analysis, but most of them have inherent assumptions, and without understanding the impact of these assumptions, the use of the software could make the analysis results invalid.

This course introduces the various common misconception in the analysis of reliability test data from which the essential knowledge of reliability statistics will be identified. Various methods of extrapolation of the test data obtained at accelerated test conditions to normal operating conditions will also be introduced, and the cautious use of the Arrhenius equation is also emphasized.

5) Product Qualification and Supply Chain Responsibilities
- Prof Michael Pecht, Director/CALCE, UMD, USA

Today, products are changing very rapidly, customers have more choices, tremendous price pressure exists on suppliers, and there is pressure to test quickly. However, the traditional test and qualification standards are not working. Over the past 10 years, there have been an increasingly large number of products that have passed qualification tests but have failed in the field. The resulting costs of these failures have been in the hundreds of millions of dollars for many companies.

This lecture presents the role of qualification in product development and the responsibilities within product supply chains. A processes to establish proper qualification methods will be provided. Virtual qualification, accelerated testing, target application requirements, and failure mechanisms and models will be discussed. In addition, various advanced qualification and supply chain techniques, including prognostics and in-situ product monitoring methods will be overviewed.
Education Course II  (Fri, 11th Dec 2015)

Practical Surface Engineering Process and Interface Analysis

1) Electron Beam Technology: Tools and Microelectronic Applications
   - Mr Tan Teck Beng, Shimadzu, Singapore

Electron Beams techniques such as Scanning Electron Microscope (SEM), Electron Probe Micro Analyzer (EPMA), Scanning Auger Microscope(SAM), Transmission Electron Microscope(TEM) have been used widely to characterize materials in Microelectronic. Each of these techniques captures different signals which arises from the interaction between the electron beam and the material. They therefore reveals different aspect of the materials in analysis. Such information is often critical in the production as well as failure analysis in microelectronic.

The course will attempt to introduce the different signals that are generated from electron beam interaction and the related properties which can be glean from these signals. Where possible, examples will be given to illustrate the points. The merits as well as the limitation of these techniques will also be discussed to enable user to decide which electron beam technique is most relevant to their need.

2) Sample preparation: Recent Advances
   - Mr Kenny Lim, Struers, Singapore

Introduction of Struers A/S - General preparation issue on composite materials - Very hard and soft material composite, Rounding/Relief, smearing, flatness and scratch - Various steps affecting the final preparation result, Cutting - Selection of cut-off wheel/Clamping of sample/Feed speed and force - Mounting, Edge retention/Resin hardness versus material hardness/Hot press method versus cold mounting - When to consider vacuum impregnation - Grinding and Polishing, Positioning of automatic polishing head - Direction of mover head and disc, Flatness - SiC papers versus SiC foils, SiC foils versus Diamond disc - SiC foils versus Rigid disc, Polishing, Difference between soft and hard polishing cloth - Suspension, Various form of diamond suspension and selections - Convention – diamond suspension with lubricant - Integrated – diamond suspension pre-mixed with lubricant - Avoid the use of alumina suspension, Oxide polishing - Achieve scratches free and good micro grain structure, Practical tips
3) ESCA: Principle and Applications
   - Dr Jisheng PAN, A*STAR, Singapore

X-ray Photoelectron Spectroscopy (XPS), also known as ESCA (Electron Spectroscopy for Chemical Analysis), is an extremely surface sensitive non-destructive technique that provides quantitative surface chemical state information for all elements except hydrogen and helium. It is the most established (since the mid-1960s) and widely used surface analysis technique. In this presentation, firstly, I will give you some basic knowledge of XPS such as its physical basis, why is the XPS technique surface sensitive? Chemical shifts, angle resolved XPS, quantification of XPS, small area XPS and Imaging XPS, XPS depth profile. Secondly, I will show you the development of XPS instrumentation and some points in XPS measurement and data process such as charge compensation and referencing for insulators and spectral fitting. Finally, I will give you some examples of its application in material surface and interface analysis such as determination of surface contamination, thickness of thin film, heterojunction band offsets, material work function and size of nano-particles.

4) Surface Engineering: Principle, Equipment and Application
   - Mr Ranjan Rajoo, Global Foundries, Singapore

5) SIMS and Industrial Applications
   - Dr Lim Sin Leng, Surface Science Lab, Physics, NUS, Singapore

About the Key note Speakers and Course Facilitators

Prof Michael Pecht has a BS in Acoustics (Physics Department), an MS in Electrical Engineering and an MS and PhD in Engineering Mechanics from the University of Wisconsin at Madison. He is a Professional Engineer, an IEEE Fellow, an ASME Fellow, an SAE Fellow, and an IMAPS Fellow. He is a world renowned expert in strategic planning, design, testing, IP and risk assessment of electronic products and systems. In 2011, he received the University of Maryland’s Innovation Award for his new concepts in risk management. In 2010, he received the IEEE Exceptional Technical Achievement Award for his innovations in the area of prognostics and systems health management. In 2008, he was awarded the highest reliability honor, the IEEE Reliability Society’s Lifetime Achievement Award. He previously received the European Micro and Nano-Reliability Award for outstanding contributions to reliability research, 3M Research Award for electronics packaging, and the IMAPS William D. Ashman Memorial Achievement Award for his contributions in electronics analysis. He is the editor in chief of IEEE Access, served as chief editor
of the IEEE Transactions on Reliability for eight years, was chief editor for Microelectronics Reliability for seven years, an associate editor for the IEEE Transactions on Components and Packaging Technology, and on the advisory board of IEEE Spectrum. He is the founder and Director of CALCE (Centre for Advanced Life Cycle Engineering) at the University of Maryland, which is funded by over 150 of the world’s leading electronics companies at more than US$6M/year. CALCE received the NSF Innovation Award in 2009. He is currently a Chair Professor in Mechanical Engineering and a Professor in Applied Mathematics at the University of Maryland. He has written more than 20 books on product reliability, development, use and supply chain management and over 500 technical articles. He has also written a series of books on the electronics industry in China, Korea, Japan, and India. He consults for 22 international companies.

Prof Sow Chorng Haur received a B.Sc. Degree (1st Class) in Physics from the National University of Singapore (NUS) in 1991. After spending two more years in NUS for research, he received a M.Sc. degree in Physics. He then went on to The University of Chicago and completed his PhD degree in 1998. During the period in 1999-2000, he worked as a postdoctoral fellow at Bell Laboratories, Lucent Technologies. He returned and joined the Department of Physics, NUS in 2001. He is now the head of the Department of Physics at NUS. He has authored and co-authored over 300 papers in the field of nanoscience and nanomaterials. His current research interest include, Colloid Interactions, Nanostructured Functional Materials and their Unique Physical properties, Assembly and Phase Transitions and Carbon Nanotubes and Graphene. A firm believer of “Science for all”, he developed the highly interactive Physics Demonstration Laboratory in NUS. The “Demo Lab” has since received more than 5,000 visitors, playing host to students at levels ranging from Primary Schools to University. More details are at http://www.physics.nus.edu.sg/staff/sowch.html

Dr. Michael Osterman, Mechanical Engineering, University of Maryland, College Park) is a Senior Research Scientist and the director of the CALCE Electronic Products and System Consortium at the University of Maryland. He heads the development of simulation assisted reliability assessment software for CALCE and simulation approaches for estimating time to failure of electronic hardware under test and field conditions. Dr. Osterman has assisted companies with transition to lead-free and in simulation based assessment of electronic assemblies. In addition, he has lead CALCE in the study of tin whiskers since 2002 and has authored many key articles related to the tin whisker phenomenon. Dr. Osterman served as a subject matter expert on phase I and II of the Lead-free Manhattan Project sponsored by Office of Naval Research in conjunction with the Joint Defence Manufacturing Technical Panel (JDMTP). Further, he has written various book chapters and more than seventy articles in the
area of electronic products and systems reliability. He is a member of ASME, IEEE, and SMTA.

**Prof. Tan Cher Ming** received his Ph.D. in Electrical Engineering from the University of Toronto in 1992. He has 8 years of working experiences in reliability in electronic industry (both Singapore and Taiwan) before joining Nanyang Technological University (NTU) as faculty member in 1996 till 2014. He is now a Professor in Chang Gung University, Taiwan and Executive Director of Institute of Reliability Science and Technology, Taiwan. He has published more than 260 International Journal and Conference papers, and holding 10 patents and 1 copyright for reliability software. He has given more than 50 invited talks in International Conferences. He has written 5 books and 4 book chapters in the field of reliability. He is also the Series Editor of Springer Brief in Reliability.

**Dr. Hee Taik YUM:** Received Ph.D. from Seoul National University, and for 23rd years, he worked as a professor of Metallurgical Dept. of SNU. After retired from SNU, open Korea Surfin Consultant Co., as a consultant until at present. At 1963, established Korea Institute of Surface Engineering (society) and became first president of this Society. For 29 years, he has been technical adviser of Samsung Electro-mechanics Co, Ltd, and for 4 years from 2006-2010, worked as a president of International Union for Surface Finishing(IUSF) and hosted as a chairman of world congress of Interfinish2008 at Busan, Korea. He has also published several books on metal finishing. Recently, he has co-developed with MKE Co., Ltd., manufacturer of gold lead wires and solder balls, on lead-free solder(SAC) electroplating on copper core balls(CCSB) sizing 120-180 um.

**Dr. Gopal Krishnan:** Received Doctoral degree from Physics Department/National University of Singapore (NUS) and currently works as Technical Advisor and consultant supporting Scientific Research and Industry Technology Development through advanced analytical technologies and road mapping. He has founded the Symposium on Surface Engineering for Industrial Applications at Singapore in 2005 with SSEA and has been the conference General Chair/Joint-Chair at Singapore, Chennai/India and Russia. He has founded A-IATS/Singapore (http://www.a-iats.com/) and Surface/Technologies/Chennai/INDIA and play advisory role. Dr Krishnan is also serving as Senior Research Fellow (Adj) at Physics, NUS, Singapore since 2010 and is reachable at (phyrgan@nus.edu.sg) or http://www.researchgate.net/profile/Gopal_Krishnan2

**Mr. Tan Teck Beng** is Product Specialist in Shimadzu Asia Pacific for OES, XRF, XRD, EPMA, SPM and ESCA. He has conducted
numerous Application Seminars and Workshops on Materials Characterization/Failure Analysis/Restriction of Hazardous Substances to greater than 200 companies in countries supported by Shimadzu Asia Pacific. He has an MSc degree in Materials Science from the National University of Singapore.

Dr. Jisheng Pan received his B.Sc. in Physics from Hangzhou University (currently, Zhejian University) in 1985 and his M.Sc. in Nuclear Physics in 1988 from Shanghai Institute of Nuclear Research (currently, Shanghai Institute of Applied Physics), Chinese Academy of Sciences, where he worked for 6 years in nuclear technology. He graduated in 1998 with his PhD in surface physics from National University of Singapore. Currently, he is a senior scientist and photoemission spectroscopy (PES) group leader in IMRE. He has also provided surface analysis and consulting service to many local and international companies in Singapore. Dr. Pan has received many awards including achievement award from A*Star aerospace programme in 2015, assessor award (silver) from Singapore Accreditation Council (SAC) in 2015, He is a session chairman in European Conference on Surface Science 2015, a technical assessor for Singapore Accreditation Council (SAC), a technical committee member of ISO/TC 201 surface chemical analysis, Singapore, one of editors, Journal of Spectroscopy, a member of MRS (USA), MRS (Singapore), IPS (Singapore) and NSC (China).

Mr Kenny Lim has graduated with a Bachelor of Business in Administration. He has been working with Struers/Singapore since May 2007 and trained as a TRAINER, sharing his knowledge and skills through training courses around this ASEAN region. He is specialized in sample preparation, especially electronic parts. Currently he serves as an Area Sales Manager at Struers, Singapore.

**Registration Fee**

Registration fee for Symposium* (9-10 December 2015)

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Registration fee for Courses** (08 & 11 December 2015)

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* This includes, tea break, lunch, abstract booklet and visit.
** This includes E-course notes, tea break and lunch.
- A 10% discount will be given for a participant attending both the courses and symposium.
- Discounts are not applicable after 27th Nov 2015.

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Early bookings must be paid in full by 27th November 2015 to qualify for the discounted or reduced rate.
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