professional development courses

1/2 Day Course
9 AM – Noon

S4

Lead-Free Solders – Technology and Applications

Instructor:
Dr. Jennie S. Hwang, H-Technologies Group, Inc.

Course Description:

This course is to provide attendees a good understanding of lead-free solder from application perspectives, and to facilitate selection of lead-free compositions. These include technological base, product assessment, manufacturing consideration, and comparison among various lead-free compositions. Information is applicable to all types of packages and assemblies including QFP, BGA, Flip Chip and CSP.

What you will learn

- Gain an overall grasp of lead-free soldering
- Understand key parameters that are important to the selection of lead-free compositions
- Identify priority properties in a manufacturing environment
- Compare relative strengths and weakness of various systems
- Acquire knowledge and insights of future perspectives of solder interconnections
- Learn the slate of candidate alloys
- Receive objective recommendations

Topics covered

- Global legislation status – US, Japan, Europe
- New compositions vs. known binary Sn-Cu, Sn-Bi, Sn-Ag, Sn-Sb, Sn-Zn, Sn-In, systems
- Pros and cons of various lead free alloy systems
- Technology base of lead-free development
- Lead-free surface finish on PCB
- Lead-free component coating
- Differentiation of solder joint failure modes between Sn/Pb and lead-free
- Reflow profiling for lead-free soldering
- Manufacturing factors – cost vs. performance
- Selection criteria of various lead-free systems and compositions
- Strengthened characteristics of lead-free alloys
- Recommendations to manufacturers

Who Should Attend?

The workshop will benefit those who have an interest in the development of lead-free solder or in using lead-free solder for electronics packaging and assembly manufacturing. This may include researchers, manufacturing engineers, design engineers, quality assurance and materials and safety personnel. Management and decision-makers can benefit from this workshop in forming and implementing manufacturing strategies through a general understanding of lead-free solders.

Special Course Materials:

All attendees will receive a complimentary copy of the book Modern Solder Technology for Competitive Electronics Manufacturing, by Jennie Hwang, McGraw Hill, 1996 (List price $75) and a set of course notes.

1/2 Day Course
1:00 PM – 5:00 PM

S5

Solder Joint Reliability - Manufacturing Perspectives

Instructor:
Dr. Jennie S. Hwang, H-Technologies Group, Inc.

Course Description:

This course is to provide attendees a proper level of understanding of solder interconnection reliability in material basics, manufacturing know-how, and real-world performance, as well as the interrelation between them. This understanding is important to every step of manufacturing, from design and material selection, to the establishment of production process, and to the overall quality and performance of end-use packages and assemblies. Information is applicable to all types of interconnections including fine pitch QFP, BGA, Flip Chip, CSP, and passive components.

What you will learn

- Improved processes to achieve solder joint reliability
- How to avoid potential problems of solder assemblies
- Solder joint reliability factors
- Solution or recommendation to the specific problems or concerns; attendees are encouraged to bring along their production floor problems for discussion and solution. For those problems requiring a lab-examination, a complimentary preliminary assessment report will be provided to the attendee after the lecture (limit one per company)
- Future demands on solder interconnections

Topics

- What does it take to derive a universal life-prediction model
- Basic level of material fundamentals in solder alloys, alloy in response to temperature changes during service life, and solder alloy selection parameters
- Bulk solder vs. solder joint properties and the key factors that affect solder joint integrity
- Reliability factors of BGA array and QFP peripheral solder joints
- The role of gold, intermetallics, solder mask, palladium
- Basic failure process and principle in creep, fatigue, thermal fatigue
- Effects of large voids and reflow process parameters
- Microstructure vs. reflow profile vs. solder joint behavior
- Common failure modes of QFP, PBGA, CBGA, CSP and other types of solder joints
- Approaches to further strengthen solder materials in improving creep-fatigue resistance

Who Should Attend?

This course is an overview of solder joint reliability, designed to provide a working knowledge to all who are involved with or interested in surface mount/fine pitch/ BGA assembling. The course will provide new personnel to the industry with the necessary understanding of solder joint reliability issues and provide experienced personnel with insights into future technology advances.

Special Course Materials:

All attendees will receive a complimentary copy of the book BGA and Fine Pitch QFP Interconnections by Jennie Hwang, Electrochemical Publications, Great Britain, 1995 (List price $140), and a set of course notes.

Dr. Jennie S. Hwang has been a major contributor to SMT industry since the inception of SMT in PCB industry. Her primary interests are global market trends and technological development, particularly in SMT packaging and assembly. She is a highly popular lecturer/featured speaker worldwide and frequently solicited consultant to U.S. government, OEMs and SMT manufacturers.

She received her Ph.D. in Materials Science & Engineering from Case Western Reserve University and two M. S. degrees in Liquid Crystals and Chemistry from Kent State University and Columbia University. She is the author of over 150 publications, including the sole authorship of several textbooks related to electronic assembly and packaging. She writes the monthly column of SMT magazine, addressing critical industry issues. She is a member of the National Academy of Engineering and a fellow of ASM Int'l. She has received many honors and awards, including the Kent Van Horn Distinguished Alumni Award of Case Western Reserve University, U.S. Congressional Certificates of Recognition and Achievement, and The Hall of Fame—Women in Technology. Dr. Hwang serves on the Business Review Board for U.S. Government programs and on many boards and committees. She was national president of SMTA. She has over 25 years of manufacturing and business experience in the industry, having held senior managerial and research positions with Lockheed Martin, Hanson, PLC, and IEM. Dr. Hwang is currently president of H-Technologies Group, Inc. The company provides manufacturing and business solutions to the electronic packaging and assembly industry.

S6

Adhesion Science and Technology

Instructor:
Kash Mittal, Ph.D., Editor, Journal of Adhesion Science and Technology

Course Description:

Adhesion between similar or dissimilar materials is of cardinal importance in many technologies, *inter alia*, packaging. So the need to understand and control factors which affect adhesion is quite patent. Also, the durability of the bond (on exposure to process chemicals, moisture, corrosives, etc.) is of grave concern and importance.

This course will provide information on the factors affecting adhesion between different materials and how to harness the principles of adhesion in solving real problems. In this course the emphasis will be on the adhesion aspects of polymeric materials (used as coatings, adhesives, encapsulants, barriers, etc.) on a variety of substrates (metals, ceramics, plastics). The course is quite applied in nature with emphasis on concepts and principles.

Who Should Attend?

Research, development, process, production and manufacturing personnel who have a current or anticipated need for knowledge of adhesion should find this course of interest.

Dr. Kashmiri Mittal was associated with IBM Corporation from 1972 through 1993. Currently, he is teaching and consulting worldwide in the broad areas of adhesion as well as surface cleaning. He has initiated, organized and chaired a number of international symposia, and is the editor of fifty-four published books as well as others which are in the process of publication, dealing, for example, with adhesion measurement, adhesion of polymeric coatings, polymer surfaces, adhesive joints, polyimides, surface modification, and surface cleaning. He has received many awards and honors including the 1990 Dudley Award of the ASTM, the 1995 Thomas D. Callinan Award of the Electrochemical Society, the Adhesives Award, is a Robert L. Patrick Fellow of the Adhesion Society, and is listed in many biographical reference works. He is a founding editor of the Journal of Adhesion Science and Technology, and is a member of the editorial boards of a number of scientific and technical journals. Dr. Mittal was recognized for his contributions and accomplishments by the worldwide adhesion community, who organized, in his honor, the 1st International Congress on Adhesion Science and Technology in Amsterdam, 1995.

S7

Advanced Materials for Microelectronic, Optoelectronic and MEMS Packaging and Thermal Management

Instructor:
Dr. Carl Zweben, Composites Consultant

Course Description:

Materials selection impacts performance, reliability and cost. Increasingly, the traditional materials used in microelectronic packaging are failing to meet the requirements for optoelectronic and MEMS packaging, as well as those of new microelectronic system designs. In response, numerous advanced composites and monolithic materials have been, and are continuing to be developed. Property improvements include:

- extremely high thermal conductivities (over four times that of copper)
- low, tailorable coefficients of thermal expansion
- extremely high strengths and stiffnesses
- low densities
- low cost, net shape fabrication processes

Payoffs include:

- improved fiber alignment
- reduced thermal stresses and warpage
- lower junction temperatures
- simplified thermal design
- possible elimination of heat pipes
- weight savings up to 80%
- size reductions up to 65%
- increased reliability
- potential cost reductions

These materials provide the engineer with greatly expanded design options. Costs are continuing to decrease, making composites increasingly economically attractive. For example, some parts made of Al/SiC, a metal

matrix composite first used in optoelectronic and microelectronic packaging by the instructor in the 1980s, are now selling for the same price as the copper ones they replace. Use is increasing 10% annually. Newer materials offer significant advantages over Al/SiC. Advanced composites and monolithic materials will be the packaging materials of choice in the 21st century.

Advanced materials, such as Al/SiC metal matrix composites and carbon fiber-reinforced polymer matrix composites, are now being used in a growing number of high volume commercial and aerospace production applications at the rate of millions of piece parts annually. The expanding list of components includes carriers, heat spreaders, pin-fin heat sinks, solid and flow-through PCB cold plates, microwave modules, power semiconductor modules, and heat pipe overmolds. Products using these materials include cellular telephones and base stations, laptop computers, hybrid and electric vehicles, data storage drives and aircraft and spacecraft electronic systems.

This course provides an in-depth discussion of the materials, their properties, the processes by which they are made, and where they are being used. We also look at future directions in the technology.

Who Should Attend?

Engineers, scientists and managers involved in microelectronic, optoelectronic and MEMS packaging design, production and R&D. Packaging material suppliers.

Dr. Zweben, is an independent consultant on composites and technical advisor to the Georgia Institute of Technology NSF Packaging Research Center. He was for many years Advanced Technology Manager and Division Fellow at GE Astro Space, later acquired by Lockheed Martin, where he directed the Composites Center of Excellence. Previous affiliations include Du Pont and Jet Propulsion Laboratory. Dr. Zweben was the first, and one of only two winners of both the GE One-in-a-Thousand and Engineer of the Year awards. He is a Fellow of ASME, ASM and SAMPE, an Associate Fellow of AIAA, and has been a Distinguished Lecturer for AIAA and ASME. He is an internationally recognized expert in his field, with over 30 years of experience in commercial and aerospace composites technology. Dr. Zweben began working on aramid printed wiring boards (PWBs) at Du Pont in the 1970s. He continued the development of advanced composite packaging as director of the GE Aerospace Group Advanced Composites Center of Excellence, where he worked on low-expansion PWB programs and developed the first silicon carbide particle-reinforced aluminum (Al/SiC) microelectronic and optoelectronic packages. He has to his credit over 100 contributions to journals, handbooks and encyclopedias and has presented over 100 invited lectures, including one at the AIAA 50th Anniversary "Learn from the Masters" series. Dr. Zweben is Co-Editor-in-Chief of a 6-volume work, "Comprehensive Composite Materials." He has directed and lectured at over 150 classroom, satellite broadcast and videotape short courses in the US and Europe, including courses on advanced packaging materials at IMAPS, NEPCON and Semi-Therm.

S8

Surface Mount Technology and mBGA, CSP and DCA

Instructor:
John Kratz, NTCm Technical Director

Course Description:

These new package types will be defined and integrated into the OEM and EMS market environments by use of the Semiconductor Roadmap three and five years out. Topics of discussion will include Land Pattern development using IPC-SM-782A (amendment "A") and "non-standard" land patterns, Design for Manufacture (DfM), Materials Control and Management (MCM), industry "best practices" and Deployment Metrics for Manufacturing (DMM). This presentation will integrate the present and standard surface mount manufacturing practices with those package types that may require additional process considerations and/or modifications of accepted "best practices." These considerations will be developed with the goal of using "drop-in" or new deployment requirements while maintaining high yield and reliability metrics.

Major process steps will be reviewed which will include the following: 1) solder paste printing, 2) component pick and place, 3) solder reflow, 4) component encapsulation, 5) decontamination cleaning, 6) inspection methodology, and 7) rework techniques and issues with the goal of deploying process "additions" to existing continuous-flow manufacturing capability. Comparisons and case studies will enable the attendee to gain a quick understanding of the important issues related to new technology package types and their assembly requirements.

Who Should Attend?

This course is useful to the advanced process engineer, quality assurance, and manufacturing process engineer who requires a "knowledge-base" for expanding manufacturing capability within the framework of the package types discussed. Additionally, marketing and procurement personnel may desire to expand their knowledge of the way in which new manufacturing technology will effect their positions, capability and/or company requirements.

Special Course Materials:

The course outlines and notes will be provided to each attendee in the form of a workbook with problems and comparisons included.

John Kratz is project manager at the NATIONAL TRAINING CENTER FOR MICROELECTRONICS (NTCm) for various activities related to coordination and development of new manufacturing process requirements, selection of equipment and materials, deployment and characterization of new process and workforce training of these process requirements within a given company infrastructure. John directs research, development and writing of procurement guidelines, quality manuals and procedures for the audit of incoming and in-process functions, workmanship standards, manufacturing process instructions, and international subcontracting functional documents.

S9

Physics-of-Failure Based Application Specific Reliability Assessment of Electronic Systems

Instructor:
Patrick McCluskey, Ph.D., University of Maryland

Course Description:

For next-generation electronics, it is no longer practical to design a product for an unspecified environment, and then measure and improve the reliability of the product by

a series of test and fix steps at the latter stages of development. Fast and cost-effective product development requires that reliability be assessed for the application environment of interest in the earliest stages of conceptual design, with prototype testing used only to confirm that the designed-in level of reliability has been achieved. This reliability assessment methodology must be fast and cost-effective to permit the development of products with more features and higher quality at lower cost in a time frame commensurate with today's shorter design cycles and faster times to market. Furthermore, it must permit the rapid qualification of components making optimal use of the manufacturer's test procedures and requiring a minimum of additional testing. Finally, it must be application-specific and based on the fundamental mechanisms by which electronics fail.

This course will present such a reliability assessment approach, which is known as physics-of-failure based application specific reliability assessment. Attendees will be taught how to apply this methodology to the qualification of components and the reliability assessment of electronic systems. The course will demonstrate how to use manufacturers' test data together with failure modeling to qualify a component for use in a particular application. The course will also demonstrate the application of this virtual qualification technique to the insertion of commercial components into harsh environment applications. The use of virtual qualification for building reliability into components, modules, assemblies, and systems will also be discussed. The course will conclude with a discussion of the probabilistic nature of reliability assessment and with a demonstration of computer-aided tools for virtual qualification and application-specific reliability assessment.

Who Should Attend?

Product and process engineers who want to know how to improve product reliability and first-pass success through the up-front incorporation of design-for-reliability techniques. Quality and reliability professionals who wish to learn the latest scientific approaches for qualification, reliability assessment, and product life evaluation. Managers and technical professionals who want to learn how to reduce development costs and improve time to market while simultaneously improving product quality and reliability.

Patrick McCluskey is an Assistant Professor of Mechanical Engineering at the University of Maryland, College Park, where he is associated with the CALCE Electronic Products and Systems Center. He is the principal investigator for projects related to computer-aided reliability assessment of microelectronics, and the packaging and reliability of electronics in high power and high temperature environments. He has co-developed and taught graduate level and executive short courses on high temperature electronics, power electronics packaging, and plastic encapsulated microelectronics. He is the author or co-author of over 50 journal and proceedings articles on his research, and the co-author of two books on electronic packaging including High Temperature Electronics. *Dr. McCluskey received his Ph.D. in Materials Science and Engineering from Lehigh University in 1991, and is a member of IMAPS and IEEE CPMT.*

S10

RF/Microwave Hybrids; Principles, Materials and Processes

Instructor:
Richard Brown, Richard Brown Associates, Inc.

Course Description:

In recent years, the demands for high frequency systems and products have been growing at a rapid pace. Coupled with the continuing development of monolithic integrated circuits, MMICs are new materials and process refinement of hybrids. As a result, system and product designers are faced with the choice between hybrids and MMICs; i.e., complete system on a chip vs. hybrids with discrete devices, or more often, somewhere in-between.

This course will begin with a short, non-mathematical review of high frequency basics. Next a comparison of MMICs and hybrids is presented. The transmission line as the basic circuit component of RF and microwave hybrids will be reviewed. Hybrid "waveguide" structures will be compared as they relate to transmission line properties. The basic materials (conductors, dielectrics and substrates) and their properties will be introduced. Their effect on impedance, circuit properties and performance will be discussed. Processing technologies suitable for RF/microwave hybrids will be reviewed. Selected packaging protocols, such as vias and bonding wires, will be discussed in light of their influence on RF/microwave performance. At the completion of this course, attendees will have a better understanding of many of the critical materials and processing factors affecting high frequency circuit performance.

Who Should Attend?

This introductory course will benefit those associated with the RF and microwave arena. In particular this course will benefit those with responsibility for design and manufacturing of RF/microwave hybrids. Supervisors, engineers and technicians involved in product development, design and manufacture are encouraged to attend.

Richard Brown is a technical and engineering consultant in hybrids, with more than 30 years experience, encompassing thin and thick film, electroplating and substrate technologies. He began his career at Bell Telephone Laboratories. After joining RCA Solid State in 1968, he transferred in 1979 to the RCA Microwave Technology Center in Princeton. In 1991, Mr. Brown joined an Alcoa Electronic Packaging technology team as program manager to implement thin film on high temperature co-fired ceramic for MCMs.

He has published extensively, most recently authoring a chapter on Thin Film for Microwave Hybrids in "Handbook of Thin Film Technology," McGraw-Hill, NY, 1998, A. Elshabini-Riad, Ed. In 1995, ISHM awarded him the prestigious John A. Wagnon, Jr. Technical Achievement Award. His text, "Materials and Processes for Microwave Hybrids," was published in 1991 by ISHM, Reston, VA.

S11

Practical Methods to Design-In and Predict Surface Mount Attachment Reliability

Instructor:
Dr. Robert W. Kotlowitz, Lucent Technologies/Bell Laboratories

Course Description:

The long-term reliability of surface

mount (SM) solder interconnections remains an important issue in advanced electronics packaging technologies. The development of high-reliability SM circuit assemblies requires an understanding of the key reliability challenges and controlling design parameters. This intensive course describes the reliability hazard for SM connections and presents practical methods for SM attachment reliability assurance. These risk-mitigation processes support the needs of the electronics packaging R&D community, by providing robust design strategies without requiring a detailed understanding of complex SM reliability issues. Major topics include:

- Reliability hazard for SM connections, driven by the component-to-substrate mismatch in coefficient of thermal expansion (CTE) and strain-induced fatigue damage.
- Solder thermo-mechanical behavior during cyclic loading, and related fatigue damage induced by stress relaxation and creep.
- Case studies of at-risk and failed SM connections. Industry examples of non-robust SM assemblies resulting from materials CTE incompatibility, insufficient lead compliance, gold-tin intermetallics, marginal solder joint quality, and aggressive mechanical loads.
- Practical lead compliance evaluation process and specialized stiffness metric for corner-most leads, corresponding to the location of the relatively high-risk SM connections.
- Effect of lead compliance on SM attachment reliability, demonstrated via fatigue life statistics from industry accelerated testing programs.
- Representative commercial high-compliance lead designs that can mitigate the SM attachment reliability hazard.
- Weibull failure probability distribution for wear-out processes, as this statistical model relates to SM attachment fatigue failure. Representative Weibull failure statistics for recognized at-risk SM packages, including TSOPs and BGAs.
- Design-for-Reliability (DFR) tool for SM attachment, covering capabilities, technical foundation, application criteria, and limitations.
- Strategies for robust SM attachment, based on the interaction of package design, assembly technology, operational thermal environment, and product service life.
- Practical applications of the DFR tool for SM ceramic discrete components, selected SM leaded packages, and BGAs.

Who Should Attend?

This course will directly benefit researchers and practicing engineers involved in SM component design, advanced electronics packaging R&D, circuit-board physical design, SM interconnection reliability, quality assurance, and SM assembly. The course is also useful to managers responsible for SM component strategy, design standards, and procurement practices guided by attachment reliability considerations.

Robert W. Kotlowitz, Ph.D., is a Distinguished Member of Technical Staff in the Wireless Networks Group at Lucent Technologies/Bell Laboratories in Whippany, New Jersey, USA. He is actively involved in SM attachment reliability in wireless telecommunication equipment, SM assembly qualification, and accelerated stress testing (AST) for product assurance. Dr. Kotlowitz is well published in SM reliability assurance, advanced packaging, and AST at major electronics packaging and reliability forums in the USA and Europe. He has been a course leader in SM attachment reliability at electronics packaging conferences and commercial training centers in the USA, Europe, and Israel. He holds a Doctorate in Engineering (Applied Mechanics) from the City University of New York, and is a long-time member of the ASME, IMAPS, and SMTA.

Monday, October 8
9:00 am - 5:00 pm

M1

Wire Bonding in Microelectronics

Instructor:
George Harman, National Institute of Standards and Technology

Course Description:

Wire bond manufacturing defects range typically from about 1000 to 100 ppm, with exceptions to >10,000 and <50 ppm. In order to achieve the lower numbers in production, one must understand all of the conditions that affect both bond yield and reliability (since they are interrelated). This course will discuss many large and small wire bonding problems, as well as subjects of specified interest to hybrid device bonding. In addition, a number of advanced topics, such as high yield and fine pitch bonding will be covered. New developments (e.g., high frequency ultrasonic bonding), are included along with a major discussion of wire bonding to multichip modules and other soft substrates.

Wire bond testing and metallurgy (covering both aluminum and gold bonds); intermetallic compounds; cleaning for yield and reliability; failures resulting from electroplating; mechanical problems in wire bonding; new bond technologies and developments; how ultrasonic bonds are formed; and the metallurgy of gold and aluminum wire. It concludes with how TAB and Flip Chip Technology compare to wire bonding.

Who Should Attend?

Engineers in R&D, QA, QC, manufacturing, process development, and advanced technicians. It is assumed that participants have some familiarity with wire bonding and general device assembly technologies.

Special Course Materials:

All attendees will receive a complimentary copy of Wire Bonding in Microelectronics, by George Harman, McGraw Hill, NY, 1997 (List price $65), as well as course notes and explanations.

Mr. Harman is a Fellow of the National Institute of Standards and Technology (NIST), Department of Commerce. He received a BS in Physics from Virginia Polytechnic Institute & State University and a MS in Physics from the University of Maryland. Mr. Harman has published 50+ papers, two books on wire bonding, and holds four U.S. Patents. He was the 1995 President of ISHM and is a fellow of IMAPS and the IEEE. He has presented numerous talks, and has taught courses for the University of Arizona, State University of New York, IMAPS, and IEEE, to name a few.

M2

Metal Plating for Electronics

Instructor:
Michael McChesney, McChesney, Inc.

Course Description:

Electroplated finishes provide environmentally sound and cost effective contacts and coatings for most electronic components and systems. Plating also plays a role in hybrid fabrication and assembly and semiconductor bonding. This course will provide a foundation in electrolytic and electroless plating of precious metals, copper, tin and tin/lead. Also covered will be plating for corrosion protection and testing of electrodeposited coatings.

Who Should Attend?

This course is appropriate for design, process and applications engineers and technicians as well as sales personnel and those who specify, purchase or inspect plated components. Newcomers to the field or those who wish to broaden their knowledge of plating terminology, process specifications or the surface finishing processes involved in component manufacturing will find the course worthwhile.

Mike McChesney has worked in the surface finishing field for 33 years as both a production engineer and in process development and retired from the Avionics Division of Honeywell Inc. He has a BS in Chemistry and MS in Physics. He is a certified electroplater/finisher and a specialist in electronic finishing. He is an instructor for the American Electroplating and Surface Finishing Society and the College of St. Thomas. He now works as an independent consultant in the area of surface finishing.

M3

Technology of Screen Printing

Instructors:
Art Dobie, SEFAR America - MEC Division;
Rudy Bacher, DuPont

Course Description:

The purpose of this course is to increase the understanding of the screen printing process thereby improving production yield and quality. The critical and integrated components for screen, such as frames, screen mesh and emulsion are presented. Presented are some of the latest advancements in the screens, the compositions and the printing process that enable screen printing to meet future circuit density requirements.

The course is applications-oriented in terms of how to optimize the screen printing process; how to specify and use screens; rheology properties that affect the print; minimizing printing defects and trouble-shooting problems related to the screens and the printing process.

Who Should Attend?

This course is intended for production and process engineers, and others interested in learning how to optimize and increase the uses of the screen printing process.

Art Dobie is Manager of Technical Service and Marketing and a member of the senior management team of SEFAR America - MEC Division in Mount Holly, NJ. He has been with MEC more than 20 years since receiving his BS in Screen Printing Technology in 1980 from California University of Pennsylvania's School of Science and Technology. Art is an original instructor of IMAPS' Technology of Screen Printing *Professional Development Course, and has delivered many technical papers and presentations relating to screen printing technology to the microelectronics industry at the local, National and International levels. He is a Senior Member of IMAPS and has held numerous offices in the Keystone Chapter, including president. Art Dobie was Co-Chair of Exhibits for ISHM '97 and initiated the IMAPS Educational Foundation Silent Auction. On October 7, 1998, Art was inducted into the Academy of Screen Printing Technology, a body of 50 technical authorities representing the highest plane of technical expertise in the screen printing industry.*

Rudy Bacher has worked 37 years in Thick Film Technology for DuPont Research and Development as a Ceramic Engineer and currently as a Development Associate. He is a recipient of the ISHM Technical Achievement Award-1984; Corporate Marketing Excellence Award-1994; and IMAPS Instructor "Technology of Screen Printing" 1990-1998.

M4

Microvias and Embedded Passives

Instructor:
Dr. Rolf Funer, Ph.D., Industry Consultant

Course Description:

New PCB designs are requiring more and more component placements, more I/Os, tighter dimensions. Microvias can dramatically reduce board size, increase I/O count and reduce layer count. The numbers of passives: resistors and capacitors are increasing dramatically. By embedding the passives directly in the circuit board, valuable surface area can be saved. And performance, particularly at high frequency, can be improved. These new technologies can work together to cut weight and size—and ultimately cost. But can these concepts be implemented today? Or are they future technologies? This workshop addresses these issues, reviews all the currently available materials and processes to make microvias and embed passives. Design and testing issues, performance, reliability, applications and economics are all covered. The design and project managers attending this course will come away with an informed view if their designs are ready for microvias and embedded passives and if microvias and embed-

ded components are ready for them. PCB manufacturing and development engineers will learn what they will need to do to implement these technologies.

Who Should Attend?

This course would be suitable for engineers who are contemplating manufacturing microvia-based circuits as well as engineers and program managers who are considering incorporating microvia circuitry into their product.

Rolf E. Funer is currently a consultant to the electronic industry. His clients include component manufacturers, electronic materials, test instrument and circuit suppliers. He recently retired from AMP Corporation as Chief Technologist, Circuits and Electronic Packaging. Previously he was Technical Director for Carolina Circuits, an AMP subsidiary. Dr. Funer spent 5 years with ICI where he was Technical Director of its Electronics Division, where the new concepts of molded circuits and high density plated ceramic circuits were developed. Earlier, Dr. Funer worked at DuPont Company for 18 years in various electronic materials research, development and marketing positions. Dr. Funer holds a Ph.D. in organic chemistry from the University of Wisconsin and a BS degree in chemistry from Loyola University.

1/2 Day Course
9 AM - Noon

M5

The Greening of Microcircuitry

Instructor:
Nihal Sinnadurai, Consultant

Course Description:

The pervasive use of electronic equipment, both consumer and industrial, has historically ignored the adverse affects of its methods, its production materials, and of the disposal of its waste. Little consideration had been given to the total impact on our lives, our health and our long-term environment.

Electronics is publicly perceived as a clean, high technology industry, solely creating benefits for mankind. The electronics industry is becoming increasingly aware of the environmental impact due to its use of heavy metals, process chemicals and cleaning fluids, all of which are considered deleterious to the atmosphere, soil and water. Predictably, there have been an increasing number of environmentally conscious government initiatives in Europe, Japan and USA to reduce the negative impact to the environment by the electronics industry.

Key areas addressed by the course include the replacement of lead-free solders, the replacement of ozone depleting cleaning agents, miniaturization (reducing the amount of hazardous materials used), energy minimization (both in manufacture and use), and product disposal.

Who Should Attend:

This course will benefit those who have the responsibility of reducing the negative impact of the electronics industry on the environment. This will include industry management, engineering, manufacturing, safety and environmental personnel.

Dr. Nihal Sinnadurai was, until recently, Principal Consultant at TWI, a world-class research and technology center for materials joining technology. Since 1982 he has been a Senior Expert of the UN Development Programme (UNDP) and the International Telecommunications Union (ITU) where he has worked to establish electronics technology, along with quality and reliability methods in developing countries. He was appointed Professor of Electronics Technology at Middlesex University in 1994 and headed its Microelectronics department from 1994-1995. Previously he was departmental manager at BT Labs where he led teams developing electronics research and development and software development for intelligent telecommunications systems. He has considerable industrial experience in electronics technologies, testing and reliability development. His inventions include the HAST nonsaturating autoclave test system and liquid crystal micro-thermography. He has authored over 60 papers and contributed to 6 books within electronics. Since 1982 he has also been involved in professional development training throughout the world, and was instrumental in creating and delivering a range of intensive training programmes in electronics technology and reliability. At TWI, he developed new joining technologies and reliability methods, including a program of professional development training on microtechnology and microelectronics, which obtained IEE Institute of Physics and Institute of Materials accreditation. He holds a BSc (Honours) and MSc in Physics from the University of London, and a PhD in Reliability from the University of Southampton; he also holds fellow awards from The Institute of Physics, IEEE, and IMAPS.

M6

Fundamentals of Hybrid Microelectronics

Instructor:
Jerry Sergent, Ph.D., Consultant

Course Description:

This introductory course will cover the materials and processes used to manufacture hybrid circuits, the design process for hybrid circuits, their applications, and where the hybrid technology fits into the overall electronic packaging technology. Design, assembly methods, and applications in automotive, microwave and power telecommunications using hybrid circuits will be considered.

The materials and processes utilized to fabricate thick and thin film hybrid substrates, including thick film pastes, screen printing, firing, substrate materials, film deposition and laser trimming are covered in considerable detail. Also included are copper metallization processes, such as direct bond copper and active metal brazing.

The discussion of assembly processes includes epoxy bonding, soldering, cleaning, tape automated bonding, flip chip attachment and wire bonding. The section on packaging includes both hermetic and nonhermetic approaches. The properties of passive components utilized in hybrid microcircuits are presented.

The course concludes with a discussion of hybrid design procedures and guidelines.

Who Should Attend?

This course will be useful to those people new or peripheral to the hybrid industry. Members of electronics design groups (including management), purchasers of hybrids or electronic components, those who sell hybrid circuits or related equipment and materials, and those who are using or manufacturing hybrids also would benefit from the course content.

Special Course Materials:

All attendees will receive a complimentary copy of the book Handbook of Hybrid Microelectronics, by Jerry Sergent and Charles Harper, McGraw-Hill, NY, 1995 (List price $90), and a set of course notes.

Dr. Jerry Sergent is a Consultant in the Electronics Packaging Industry. He is a Past President of IMAPS and a recipient of the Daniel C. Hughes Award, the William D. Ashman Award, and the John Wagnon Technical Achievement Award from this organization. Dr. Sergent has over 30 years of experience in hybrid technology and is the author of two books, "Handbook of Hybrid Microelectronics" and "Thermal Management Handbook of Electronic Assemblies." He has also published more than 70 technical papers. He was recently appointed as Editor of the IMAPS Journal.

M7

Advanced Organic Substrate Package Design & Manufacturing for RF & Broadband Applications

Instructor:
Hassan Hashemi, Rockwell Semiconductor

Course Description:

The objectives of this course are to review design and manufacturing practices and tradeoffs affecting current and next generation RF & GHz Packaging using laminate substrate technologies in single or multiple die packaging format. The course material is primarily based upon the instructor's experience on current practices used for Wireless & GHz IC packaging for Internet infrastructure applications. The course is designed for engineers or engineering managers who want to understand more about laminate single or multi chip modules, and the unique requirements for assuring that packages can be manufactured in a high volume commercial application and meet stringent electrical and thermal performance requirements.

Who Should Attend?

The course is intended for both the packaging expert (Electrical and Mechanical Engineers) as well as persons new to the field. The course will concentrate on extending the existing organic substrate infrastructure capability to GHz high volume packaging applications. The information presented will include the theoretical background with practical methods for implementing a design. These same techniques can be applied to other high frequency single or multichip designs.

Hassan Hashemi is Director of Advanced Packaging at Conexant Systems, Inc., in Newport Beach, California. He is currently managing design and development of single and multi-chip packages for broadband digital, mixed-signal, and RF devices used in personal communication applications. He holds a Masters degree in electrical engineering from the University of Texas at Austin, and has over 16 years of experience in microelectronics package design, manufacturing, and product development. Prior to joining Conexant, he was a senior member technical staff at Microelectronics and Computer Corp. and Advanced Micro Devices. He holds 10 US patents, has authored three book chapters and over 40 technical papers in the areas of high speed package electrical and thermal design and implementation.

M8

Failure Analysis of Hybrid Microelectronics Packaged Devices from a Materials Perspective

Instructor:
Andrew M. Hirt, Materials Research Laboratories, Inc.

Course Description:

In the last few years, hybrid microelectronics devices have undergone a dramatic change in the scope of materials associated with them. In the past, a hybrid device generally consisted of a ceramic substrate mounted in a metal package and contained surface mount devices on a pattern that was screen printed over the ceramic. The circuitry was generally encased in a metal package and hermetically sealed for protection. The new 'hybrid' can be a composite of almost any materials. Current substrate materials include ceramics, epoxy-glass circuit boards, flexible metallized polymers, plastics and anything else to which someone can find a way to attach a circuit pattern. Packages may be metals, ceramics, plastics, epoxies or missing altogether. With this no-holds-barred attitude toward applicable materials, the ability to perform a successful failure analysis study becomes much more difficult. Adding to the problems associated with failure analysis studies is that the hybrid has moved from primary usage in military and aeronautics applications to virtually any item that requires some form of electronic control. The local environments have expanded to the very harsh while the protection provided many hybrid circuits by encapsulation or sealing have diminished. A benefit to the overall performance of current hybrids is that the problems are generally identified, corrected and implemented quickly. A further downside, however, is that tracking the problem that caused the failure to its root source may involve several industries, shipments and plants, many of which may not have the needed records, retains, etc., that can produce useful results. In addition to the proliferation of problems associated with hybrid production, the number of analytical tools available to the failure analyst has expanded.

This short course will provide a structured approach to the failure analysis of hybrid microelectronics devices. The course will include discussion of the selection of analytical protocols and techniques and the interpretation of results. The information presented will offer insights into the root cause of failures from the materials perspective. These might include original design faults (usually assumed to have been eliminated prior to production implementation), materials failures due to processing (mechanical, chemical, etc.) or environment, shipping and handling damage, etc.

Who Should Attend?

This course will be useful to those involved in the analysis of hybrid microelectronics devices that have experienced failures, particularly for unknown reasons after prior successful manufacture. Members of electronics design groups, quality control departments and research and developments groups. Course notes will be provided.

Andrew M. Hirt was awarded a degree in Physics from the Case Institute of Technology where he had been associated with the Department of High Energy Physics and with the Thin Film Physics Laboratory. Since 1975 he has been involved in the application of surface analytical instrumen-

tation to the study of solid materials. In his involvement as founder and senior scientist with Materials Research Laboratories, Mr. Hirt has studied the surface physical and chemical characteristics of many different materials systems including numerous electronic and microelectronic products, surface cleaning/preparation processes and solid/liquid and solid/gas interactions. He has studied the surface chemistries of several metal and polymer systems extensively and has developed numerous cleaning/modification processes for various industries. Author or editor of fifty papers, presentations and books, he is a member of and has served on the executive boards of several professional societies and actively participates in local, national and international meetings and symposia. Mr. Hirt is listed in American Men and Women of Science.

M9

Critical Materials Factors in High Performance Electronics

Instructor:
Charles A. Harper, Technology Seminars, Inc.

Course Description:

This course will detail both the critical electrical and critical non-electrical parameters, which are vitally important to success in modern electronic assemblies and systems. In addition, the material presented will discuss the various substrates, especially circuit boards and ceramic substrates, and will address the new, high performance substrates. Tradeoffs for these substrates will be presented along with advantages and limitations of the high performance substrates. Other materials and material forms which are critical in today's high packaging density, high speed circuitry, and other high performance parameters will also be discussed.

For critical electrical parameters, the key electrical properties will be defined and illustrated, and the effects of major operating environments will be explored. Discussions will cover all electrical functions, including resistance and resistivity, voltage, and loss functions such as dielectric constant and dissipation factor and their variations. Often not understood anomalies of these functions will also be reviewed.

For critical non-electrical parameters, discussions and explanations will parallel those listed above for critical electrical parameters. Particular emphasis will be placed on properties of importance in the highly sensitive operational environment of thermal excursions, which almost always lead to failure problems in electrical equipment. These properties include thermal expansion, thermal stability and thermal life, and thermal conductivity. Methods for optimizing materials performance will be discussed. Other critical operating environments, and materials performance in these environments will be analyzed, along with methods for optimizing performance.

Who Should Attend?

This course will be useful for all of those interested in understanding critical materials properties and the performance and optimization of materials for important operating environments. This includes engineering, manufacturing, process, quality, marketing, and others involved in development, design and manufacture of electronic assemblies and systems.

Special Course Materials:

All attendees will receive a copy of the new Electronic Packaging and Interconnection Handbook, by Charles A. Harper, McGraw-Hill, 2000 (List price $125), and a set of course notes.

Charles A. Harper is President of Technology Seminars, Inc., of Lutherville, Maryland. He is widely recognized as a leader in materials for product design, having worked and taught extensively in this area. Mr. Harper is also Series Editor for the Materials Science and Technology Series, and the Electronic Packaging and Interconnection Series, both published by McGraw-Hill. He has been active in many professional societies, including the Society of Plastics Engineers, American Society for Materials, and the Society for the Advancement of Materials Engineering, in which he holds the honorary level of Fellow of the Society. He is a Past-president and Fellow of the International Microelectronics and Packaging Society. Mr. Harper is a graduate of the Johns Hopkins University, Baltimore, Maryland, where he has also served as Adjunct Professor.

M10

Fundamentals of Fabrication and Packaging of MEMS and Related Micro Systems

Instructor:
Ajay P. Malshe, Ph.D., University of Arkansas

Course Description:

This introductory course will cover packaging and integration of micro-electro mechanical systems (MEMS). Unlike integrated circuit (IC) packaging, MEMS packaging is highly *application specific*. MEMS and related micro systems are designed, fabricated and packaged for various applications, for example accelerometers, gyros, RF switches, optical switches, micro fluidic drug delivery systems, etc. Moreover, growing trend demands multifunctional systems where integration of these diverse signals results into true "mixed signal systems." Hence, a growing number of products need application-specific design, materials, fabrication and assembly processes for building reliable MEMS systems.

The course has two sections. The first will introduce and discuss fundamentals of various MEMS and related microsystem products, and their packaging and assembly requirements. It will further touch upon the basics of surface and bulk micro machined MEMS fabrication processes including M4 techniques and various materials used to make these devices. The second part will discuss in length classification of MEMS packaging processes, packaging and assembly issues such as dicing, stiction, interconnection, out gassing, ambient specific packaging, reliability, etc. The course concludes with a discussion of MEMS market and manufacturing trends.

Who Should Attend?

MEMS and related micro systems packaging business offers new opportunity to traditional IC packaging scientists, engineers and businesses. Further this area is evolving rapidly and hence, understanding the fundamentals is key for developing and packaging reliable products. Thus, this course is useful to scientists, engineers and business

managers working in the areas of designing, fabrication, assembly, testing, and marketing of materials, software, equipment and processes for MEMS and related products. Also, this course will benefit people looking for new business opportunities, which are there worldwide.

Ajay P. Malshe, Ph.D. (1992), is an Associate Professor at the Department of Mechanical Engineering and an adjunct faculty with High Density Electronics Center (HiDEC), Department of Electrical Engineering, University of Arkansas, Fayetteville, AR. He is a Materials Scientist and Engineer. His two distinct fields of research interest are integration and packaging of MEMS and related micro and nano systems, and surface engineering for meso and macro systems. He has authored over eighty referred publications, holds four patents, contributed one book chapter and has delivered numerous invited talks. He has achieved many awards for technical contributions. He has ongoing collaborations with large corporations and small businesses in US and has working collaborations with various organizations overseas. He is currently an active member of International Microelectronics And Packaging Society (IMAPS) through the organization of Advanced Technology Workshops (ATW), for example in the areas of MEMS Packaging and thermal management, Chairman of Thermal Management Technical Sub-committee and National Chair of ATWs. He is also the Faculty Advisor of IMAPS's local student chapter. In addition, he is a member of ASME, ASEE, and MRS professional societies.

M11

Area Array Technology – Processes, Materials, Packages and Reliability

Instructor:
Dr. Wayne Johnson, Ph.D., Auburn University

Course Description:

The increasing number of I/Os (inputs/outputs) per semiconductor chip combined with the product driven requirements of thinner, smaller and lighter weight have led the electronics packaging and assembly industry to area array packages and assembly. The new area array package and assembly approaches are replacing the traditional perimeter approaches: quad flatpacks (QFPs) by ball grid array (BGAs), thin small outline packages (TSOPs) by chipscale packages (CSPs) and chip-on-board (COB) by flip chip on laminate (FCOL). This course will begin by examining the drivers for area array packaging, then examine the packaging options, their construction and trade-offs. Substrate design requirements will be discussed including routing, pad design and the reliability impact of design. Major assembly issues are flux selection, underfilling, if necessary, and inspection. Underfilling which is not a traditional SMT assembly process is required for FCOL and often for CSPs. The underfill process and material options will be examined. Recently, wafer applied underfill material concepts for FCOL assemblies have been discussed and this new technology concept will be explored. The course will conclude with a discussion of packaging reliability. The replacement of leads by solder spheres impacts reliability, particularly in thermal cycling and bending, and must be considered prior to implementing area array technology.

Who Should Attend?

This course is designed for staff members, technical managers, supervisors, systems designers, and manufacturing engineers in companies using or planning to use area array packages or flip chip. Materials and equipment suppliers for area array assembly will also benefit by gaining necessary background information.

Dr. Johnson is an Alumni Professor of Electrical Engineering at Auburn University and Director of the Laboratory for Electronics Assembly and Packaging (LEAP). At Auburn, he has established teaching and research laboratories for advanced packaging and electronics assembly. Research efforts are focused on materials, processing, and reliability for electronics assembly. He has worked in MCM design, MCM-L, -C and -D substrate technology as well as advanced SMT, wire bond and flip chip assembly techniques. He has published and presented numerous papers at workshops and conferences and in technical journals. He has also co-edited one IEEE book on MCM technology and written two book chapters in the areas of silicon MCM technology and MCM assembly. He received the 1997 Auburn Alumni Engineering Council Senior Faculty Research Award for his work in electronics packaging and assembly.

Dr. Johnson was the 1991 President of the International Society for Hybrid Microelectronics (ISHM). He received the 1993 John A. Wagnon, Jr. Technical Achievement Award from ISHM, was named a Fellow of the Society in 1994 and received the Daniel C. Hughes Memorial Award in 1997. He is also a member of IEEE, SMTA, and IPC.

Dr. Johnson received B.E. and M.Sc. degrees in 1979 and 1982 from Vanderbilt University, Nashville, TN, and Ph.D. degree in 1987 from Auburn University, Auburn, AL, all in electrical engineering. He has worked in the microelectronics industry for DuPont, Eaton, and Amperex.

M12

Integrated Circuit Packaging and Assembly Technologies - Issues and Concerns

Instructor:
William J. Greig, Greig Associates Inc.

Course Description:

This course addresses how Microelectronic Packaging and Assembly are driven by the intrinsic demands of both the Integrated Circuit, and End Product requirements for "smaller, better, cheaper." It focuses on packaging trends, namely, the BGA, the CSP, the MCM, and COB and the available assembly options that include, Chip & Wire, TAB, and Flip Chip. The course also covers High Density Interconnect substrates (HDIs). The various substrate manufacturing technologies (Thick Film, Co-fired Ceramic, and Thin Film) will be reviewed and the latest developments in high density, fine line, Printed Wiring Board manufacturing discussed. Through out the course the technical issues will be emphasized and reliability concerns addressed where appropriate.

Who Should Attend?

The course provides a comprehensive overview of microelectronic packaging and assembly and is intended for individuals in any way involved with electronics manufacturing. Discussing current and future trends, it is directed towards both the experienced or inexperienced engineer and technician, and management personnel with the "need to know." It should be of particular interest to those in support activities such as procurement, quality assurance, marketing, and program office by providing a technology

base in support of strategic planning and implementation.

Special Course Materials:

All attendees will receive a complimentary copy of the book, Hybrid Microcircuit Technology Handbook, J. Licari, L. Enlow, 2nd Edition, Noyes Publications, 1998, and a set of course notes.

William "Bill" Greig is currently an independent consultant specializing in microelectronics packaging and assembly. His previous work experiences include RCA Semiconductor, General Electric Co., Lockheed Electronics, and NASA. His areas of expertise covers semiconductor wafer processing and assembly, hybrid circuit manufacture, and printed wiring board fabrication. He is experienced in assembly technologies such as chip & wire, TAB, and flip chip. He has been granted 6 patents and has published or presented numerous papers at the various technical symposia. He has developed and presented courses at national symposia and participated in CEE programs at U. of Wisconsin, Lehigh University and Rutgers University. He is a member of SMTA and IMAPS and is currently President of the Garden State Chapter.

Come Celebrate Octoberfest!

Tuesday, October 9, 2001
4:30 pm - 6 pm

IMAPS 2001 Exhibitors will be hosting an Octoberfest. Certain exhibitors will be offering food and beverages in the style of an authentic German Octoberfest.

IMAPS will provide each attendee with a map showing which exhibitors are participating to help make your tour as easy as possible.

Mark your calendars – you won't want to miss this event!

Interested exhibitors should contact Ann Bell via email at abell@imaps.org.

M13 **FOR STUDENTS ONLY! - FREE**

Microelectronic Systems Packaging: Careers, Technologies and Markets

1/2 Day Course • 1:00 PM - 5:00 PM

Instructor:
Prof. Rao R. Tummala, Petit Chair Professor, Director NSF-PRC, GRA Scholar
Georgia Institute of Technology

Information technology involves hardware, software, applications and services. This industry has become the largest industry surpassing agriculture that lasted more than a millennium and steel that lasted more than a century. It is becoming the driving engine for science, technology, manufacturing and services paving the way for unparalleled prosperity of people and countries that participate in it. Better than 80% of all millionaires in the U.S. during the last five years have been attributed to this industry.

Microelectronics systems packaging involves all the technologies in forming electronic systems for consumer, telecom, computer, automotive, aerospace and medical industries. These technologies typically involve all the components and their interconnections to form system level boards to provide system level functions. Microelectronics packaging is the ultimate cross-disciplinary technology that involves engineers from various backgrounds. For example: electrical design typically performed by Electrical or Electronic and Computer Engineers; thermo-mechanical design by Mechanical Engineers; development of new materials that provide the required functions by Materials Engineers; fabrication of components by Chemical Engineers; electrical test by Electrical or Electronic Engineers; IC and board assembly by Mechanical or Materials Engineers; thermal management and reliability by Mechanical Engineers; and so on. Working together as a team from all these disciplines, packaging engineers design, fabricate, integrate, test, cool and assure reliability of the entire microelectronic system.

This four-hour course will present the global microelectronics market, past and future technologies that constitute this market, the educational opportunities that are available and career prospects for a lifelong career around the world in various industries.