Symposium's Technical Chairs Welcome Letter

Dmitry Marchenko

Dr. Parshant Kumar

We'd like to welcome everyone to the 43nd Annual New England *i*MAPS Symposium! Thanks to all the Session Chairs we've compiled an engaging program of technical talks on many of today's hot topics that will peak the interest of every Attendee. We hope you take full advantage of the opportunity to interact with the speakers and each other in a learning environment that's only available at this unique one day symposium. Below is a brief summary to help you on your way and don't forget to spend time in the exhibit hall, because after all without the support of the exhibitors this day wouldn't be possible. Enjoy!!!

RF and Microwave - Innovations and Emerging Technologies: This session is all about the innovations and emerging technologies that are driving RF and microwave packaging industry. Returning by popular demand and includes talks from industry leaders such as CST, Ametek and Draper. The topics cover issues like EM coupling between buck converters and antennas, Low Loss Additive Materials and design challenges of millimeter-wave semiconductor packaging.

3D and Beyond: This session covers the latest advancements in 2.5/3D technology. A Novel way to produce 3D chip assemblies called Quilt will be presented by IIC. Presentation by Tufts will describe liquid metal interconnects use in studies of animals and soft robots. You will learn about the latest Draper work on Printed transceivers.

High Reliability Interconnect session gives an opportunity to hear about the latest advancements in heavy copper wire bonding for mass productions at Hesse. Rochester Electronics will discuss process optimizations on advanced aluminum wirebond tools. Tanaka will report on the use of submicron Au particles for Low Temperature Au-Au bonding. You will get a chance to hear the latest updates regarding Niobium wire from Auburn University.

Medical Device Packaging: Miniaturized medical electronics is becoming more and more widespread. To learn more about unique challenges of packaging medical devices, please attend this session. After the introductory talk we will discuss transistor-less, wireless implant work and brain activity monitors from Draper and Ultra-Low Power RF implants from IPDIA This session is too good to miss!

SMT and Electronics Packaging: Surface mount technology is alive and well in the New England area. This session looks at the results of a 20 year shelf life study of surface finishes done by ST and S. TAS Consulting will report on advancements in flexible electronics packaging, and you will get a chance to hear about Enthone's work on organic-metal final finishes.

Printed Electronics is a set of printing methods used to create electrical devices on various substrates and this disruptive technology is being adopted by many different industries, with strong leaders right in our region. This session includes a presentation from the Army, which is pioneering the use of this technology within the DOD, and focuses on Next Flex – Flexible Hybrid Electronics initiative. Equipment suppliers Optomec and nScrypt will discuss their latest advancements in additive manufacturing systems.

Nanoelectronics and Optoelectronics Packaging session will include a presentation by Raytheon about efforts to integrate Si and III-V technologies. UMass Lowell will discuss their latest work in nanosolders and graphitic carbon nitride. This session also includes a special presentation by Northeastern University about the printing of microscale heterogeneous electronics and sensors

Poster Session: This year the competition in the poster session is really heating up. 500 dollars to the first place winner! The posters cover 3D printing, nanomaterials, biotech and counterfeit prevention! The students are our future so please set aside some time to go and talk with each of them to learn what's new on the horizon.

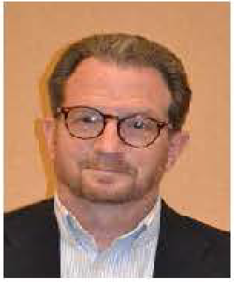
We welcome your feedback and have a wonderful day!!!

Kind Regards, Dmitry Marchenko

Dmitry Marchenko   Dr. Parshant Kumar

2016 *i*MAPS New England Symposium Technical Chairs

IMAPS New England Executive Committee 2015-2016

 **Dr. John Blum** President *Triton Systems*	 **Jon Medernach** Vice President *MRSI Systems*	 **Minh Tran** Treasurer *Mini Systems*	 **Mike Gervais *** 1st Past President *Geib Refining*	 **Dr. A. Mahapatra** Education *Linden Photonics*
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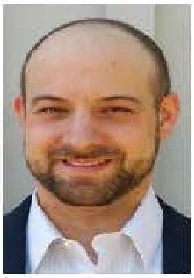
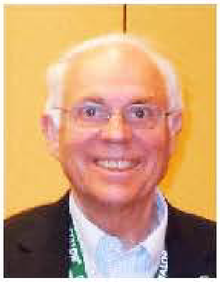
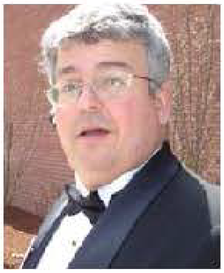
 **Jeremy Lug** Membership *Metrigraphics*	 **Jim McLenaghan** Tech Meetings *Creyr Innovation*	 **Matt Bracy** Registration *MSD Sales*	 **Joe Soucy** Photo/Proceedings *Draper*	 **Tom Marinis *** CD/Proceedings *Draper*
* denotes Past Presidents	 **Dr. Rita Monanty *** Past President		 **John Redman *** Board Member *Superior Technical*	* denotes Past Presidents

Keynote Lunch Address

“Trillion Sensors for Health Care”

Presented by Dr. Ahmed A. Busnaina,

William Lincoln Smith Professor,
Distinguished University Professor, & Director
The NSF Nanoscale Science and Engineering Center for High-rate Nanomanufacturing,
Northeastern University, Boston, MA 02115

12:15 – 12:45 - Exhibit Hall

Keynote Abstract

Printing offers an excellent approach to making sensors and devices using nanomaterials, however, current electronics and 3D printing using inkjet technology, used for printing low-end electronics are slow and provide only micro-scale resolution. The NSF Center for High-rate Nanomanufacturing (CHN) has developed a new fully automated system that uses directed assembly based printing at the nanoscale to make products that fully take advantage of the superior properties of nanomaterials. The Nanoscale Offset Printing System (NanoOPS) can print metals, insulators and semiconductors (including III-V and II-VI), organic and inorganic materials into nanoscale structures and circuits (down to 20 nanometers). The printer has demonstrated many applications such as sesnors, electronics, energy and medical devices. A variety of sensors have been printed, among them a micro biosensor chip capable of detecting multiple biomarkers simultaneously (in vitro and in vivo) with a detection limit that’s 200 times lower than current technology. In addition, the center made a printed Band-Aid sensor that could read glucose, urea and lactate levels using sweat or tears. This novel, flexible carbon Nanotube conductance based sensor platform for instantaneous measurement of various pathogens and for monitoring physiological parameters of human body for applications in the wearable health and environmental monitoring. These sensors comprises of highly sensitive and selectively functionalized s-SWCNTs. We show that D-glucose, L-lactate, Urea, E. coli, and Adenovirus were detected with very high sensitivity, selectivity, stability and repeatability. This developed biosensor platform detects D-glucose, L-lactate, Urea, E. coli, and Adenovirus over a wide range in a few seconds making them suitable for many applications.

Biography

Dr. Ahmed A. Busnaina, is the William Lincoln Smith Chair Professor, Distinguished University Professor and founding Director of National Science Foundation’s Nanoscale Science and Engineering Center for High-rate Nanomanufacturing and the NSF Center for Nano and Micro-contamination Control at Northeastern University, Boston, MA. Prof. Busnaina is internationally recognized for his work on nano and micro scale defects mitigation and removal in micro and nanofabrication. He specializes in directed assembly of nanoelements and in the nanomanufacturing of micro and nanoscale devices. He developed many manufacturing techniques for nanomaterials based energy, electronics, biomedical and materials applications. His research support exceeds $50 million. He authored more than 600 papers in journals, proceedings and conferences in addition to 25 filed and awarded patents. He is an associate editor of the Journal of Nanoparticle Research. He also serves on many advisory boards including Samsung Electronics. He is a fellow of the American Society of Mechanical Engineers, and the Adhesion Society, a Fulbright Senior Scholar and listed in Who's Who in the World.

43rd Annual Symposium - Tuesday May 3rd, 2016

Technical Program - Quick Guide

Session			Room	Chairs	# Papers
Sessions 8:30 – 11:30 AM					
Morning	**A:**	**RF and Microwave - Innovations & Emerging Technologies**	**Seminar**	**Tom Terlizzi** **Dr. Tracey Vincent**	**6**
	B:	**High Reliability Interconnects**	**Cotillion**	**Mike McKeown** **Bill Boyce**	**6**
	C:	**SMT and Electronics Packaging**	**Directors**	**Tina Barcley** **Mike Martel**	**5**
	D:	**Printed Electronics**	**Colonial**	**James Zunino III** **Dr. Katherine Duncan**	**6**
	H:	**Posters (all day)**	**Exhibit Hall Presenters: 2:00 – 3:30 PM**	**Dr. Zhiyong Gu** **Dr. Rita Mohanty**	**9**
Lunch Break – Exhibit Hall – 11:45AM – 1:15PM					

Sessions 1:00 – 3:30 PM					
Afternoon	**E:**	**Medical Device Packaging**	**Cotillion**	**Steve LaFerriere** **Tom Green**	**5**
	F:	**3D and Beyond**	**Seminar**	**Maria Durham** **Dr. A.F.M. Anwar**	**5**
	G:	**Nanoelectronics & Optoelectronics Packaging**	**Colonial**	**Dr. Alkim Akyurtlu** **Dr. Joey Mead**	**5**

Exhibit Hall Open 9:00AM – 4:30PM

43rd Annual Symposium - Tuesday May 3rd, 2016

Morning Technical Program – Session Chairs

Session		Chair		Chair	
A:	**RF and Microwave: Innovations & Emerging Technologies**	**Tom Terlizzi** **Vice President** **GM Systems LLC** 631-269-3820 terlizzi@gmsystems.com		**Dr. Tracey Vincent** **Application Eng.** **CST** 508-665-4449 Tracey.Vincenta@cst.com	
B:	**High Reliability Interconnects**	**Mike McKeown** **Business Devel. Mgr.** **Hesse Mechatronics** 516-551-8671 michael.mckeown@hesse-mechatronics.us		**Bill Boyce** **Engineering Mgr.** **SMART Microsystems** 401-523-6465 bill@smartmicrosystems.com	
C:	**SMT and Electronics Packaging**	**Tina Barcley** **CTO** **TAS Consulting** 585-301-7779 tbarcley@earthlink.net		**Mike Martel** **Owner** **MMC, Inc.** 401-396-2646 mmcmarketing@gmail.com	
D:	**Printed Electronics**	**James Zunino III** **ARDEC Project Officer** **US Army** 973-724-6773 James.L.Zunino.civ@mail.mil		**Dr. Katherine J. Duncan** **Principal Investigator** **Printed RF Structures Group** 443 - 395 - 4401 Katherine.i.duncan8.civ@mail.mil	
H:	**Posters (all day)**	**Dr. Zhiyong Gu** **Associate Professor** **Dept. Chemical Eng.** **Univ. Mass. Lowell** 978-934-3540 Zhiyong_Gu@uml.edu		**Dr. Rita Mohanty** **Director R&D** 401-265-0360 ritam1010@hotmail.com	

43rd Annual Symposium - Tuesday May 3rd, 2016
Afternoon Technical Program – Session Chairs

Session		Chair		Chair	
E:	**Medical Device Packaging**	**Steve LaFerriere** **Dir. North Am. Business Devel.** **Yole Développement** 480-922-7164 laferriere@yole.fr		**Tom Green** **Principal** **TJ Green Associates LLC** 610-625-2158 tgreen@tjgreenllc.com	
F:	**3D and Beyond**	**Maria Durham** **Technical Engr.** **Indium Corp.** 315-381-2037 mdurham@indium.com		**Dr. A.F. M. Anwar** **Professor** **Electrical & Computer Eng.** **Univ. Connecticut** 860-486-3979 a.anwara@engr.uconn.edu	
G:	**Nanoelectronics & Optoelectronics Packaging**	**Dr. Alkim Akyurtlu** **Prof., Electrical & Computer Eng.** **Univ. Mass. Lowell** 978-934-3336 alkim_akyurtlu@uml.edu		**Dr. Joey Mead** **Prof. Plastics Eng.** **Co-Dir. NanoMfg. Ctr** **Univ. Mass. Lowell** 978-934-3446 Joey_Mead@uml.edu	

Morning Session	**Seminar Room**
8:30 – 11:30	**Session A: RF and Microwave - Innovations & Emerging Technologies** **Tom Terlizzi & Dr. Tracey Vincent – Co-Chairs**
8:30	**"Investigation of Electromagnetic Field Coupling from DC-DC Buck Converters to Automobile AM/FM Antennas", Patrick DeRoy –** CST, Framingham, MA
8:55	**"ECLIPS: Embedded Cooling Layer – Integrated Power System", Al Wasserzug –** Cirexx International, Louisville, KY
9:20	**"High Dielectric Constant, Low Loss Additive Manufacturing Materials for RF/Microwave Applications", Caprice Gray –** Draper, Cambridge, MA
9:45 - 10:15	**Coffee Break in the Exhibit Hall**
10:15	**"How to Simulate RF Materials Considering Accuracy and Speed", Dr. Tracey Vincent** – CST, Framingham, MA
10:40	**"Addressing the Design Challenges of RF/Millimeter Wave Semiconductor Packaging", Craig Vieira** – Ametek-ECP, New Bedford, MA
11:05	**"Future of QML Hermetic ICs", Timothy J. Flaherty** – Golden Altos Corporation, Milpitas, CA
11:45 – 1:15	**Lunch & Keynote in the Exhibit Hall**

Afternoon Session	**Seminar Room**
1:00 – 3:05	**Session F: 3D and Beyond** **Maria Durham & Dr. A.F. M. Anwar – Co-Chairs**
1:00	**"Room Temperature Fast Flow Reworkable Underfill for LGA", Dr. Wusheng Yin** – YINCAE Advanced Materials, LLC, Albany, NY
1:25	**"Beyond Chip Stacking---Quilt Packaging Enabled 3D Systems", Jason Kulick** – Indiana Integrated Circuits, South Bend, IN
1:50	**"Challenges facing electrochemical deposition in wafer level packaging", Thomas Richardson** – MacDermid Enthone Electronics Solutions, Waterbury, CT
2:15	**"Liquid Metal Interconnects for Conformable Sensor Packaging Enabling Inertial Measurements of Animals and Soft Robots", Nikolas Kastor,** R.D. White – Tufts University, Medford, MA
2:40	**"Printed Transceiver Circuit for System-on-chip Sensor and Processor", Peter H Lewis** – Draper, Cambridge, MA
3:00	**Refreshments & Raffles in the Exhibit Hall**

Morning Session	**Cotillion Room**
8:30 – 11:30	**Session B: High Reliability Interconnects** **Mike McKeown & Bill Boyce – Co-Chairs**
8:30	**“Heavy Copper Wire Bonding for Mass Production”, Mike McKeown** – Hesse Mechatronics, Mineola, NY
8:55	**“Understanding the Role of Ultrasonic Welding in Wire Bonding”, Lee Levine** – Process Solutions Consulting, Inc., New Tripoli, PA
9:20	**“Configurations for Robust Gold Stitch-to-Substrate Wire Bond Attachment”, William Boyce** – Smart Microsystems, Elyria, OH
9:45 – 10:15	**Coffee Break in the Exhibit Hall**
10:15	**“Process Optimization on Advanced Al Wirebond Tools”, Matthew Kurtz** – Rochester Electronics, Newburyport, MA
10:40	**“Submicron Au Particles for Low Temperature Au to Au Bonding”, William (Bud) Crockett** – Tanaka Kikinzoku Kogyo K.K., San Jose, CA
11:05	**“Wire Bonding onto Niobium for Superconducting Applications”, Dr. Michael Hamilton –** Auburn University, Auburn, AL; Mike McKeown – Hesse Mechatronics, Mineola, NY
11:45 – 1:15	**Lunch & Keynote in the Exhibit Hall**

Afternoon Session	**Cotillion Room**
1:00 – 3:05	**Session E: Medical Device Packaging** **Steve LaFerriere & Tom Green – Co-Chairs**
1:00	**“Hermetic Packaging of Implantable Devices: How did we get here? And where are we going?”, Heather Dunn** – Cirtec Medical, Longmeadow, MA
1:25	**“A Transistor-less, Wireless Neural Implant”, Dr. Daniel Freeman** – Draper, Cambridge, MA
1:50	**“RF companion chip based on PICS technology for small and reliable medical device packaging: application to Ultra-Low Power RF Implants”, Dr. Mohamed Mehdi Jatlaoui** – IPDiA, Caen Area, France
2:15	**“Packaging Architecture for an Implanted System that Monitors Brain Activity and Applies Therapeutic Stimulation”, Caroline Bjune** – Draper, Cambridge, MA
2:40	**“Electronics Packaging Methods and Materials for Implantable Medical Devices”, Susan Bagen** – Micro Systems Technologies, Inc, Mesa, AZ
3:00	**Refreshments & Raffles in the Exhibit Hall**

Morning Session	**Colonial Room**
8:30 – 11:30	**Session D: Printed Electronics** **James Zunino III & Katherine Duncan – Co-Chairs**
8:30	**“Application of inkjet printing technology”, Michael Carr** – New Jersey Institute of Technology, Newark, NJ
8:55	**“Electrical Characterization of Traditional and Aerosol Inkjet Printed Conductors under Tensile and Strain”, Jake Rabinowitz** – Northeastern University, Boston, MA
9:20	**“Fully Printed Conformal Antenna and Sensors on 3D Plastic, Ceramic, and Metallic Substrates”, Mike O’Reilly –** Optomec, Inc., Albuquerque, NM
9:45 – 10:15	**Coffee Break in the Exhibit Hall**
10:15	**“Next Flex - Flexible Hybrid Electronics Manufacturing Innovation Institute”, James Zunino III –** U.S. Army RDE Command (ARDEC), Picatinny Arsenal, NJ
10:40	**“America Makes and Status of Research in Multi-Functional Printing”, Dr. Eric MacDonald –** University of Texas, El Paso, TX
11:05	**“SuperScrypt - Next Generation Additive Manufacturing System”, C. Mike Newton –** Sciperio / nScrypt, Orlando, FL
11:45 – 1:15	**Lunch & Keynote in the Exhibit Hall**

Afternoon Session	**Colonial Room**
1:00 – 3:05	**Session G: Nanoelectronics & Optoelectronics Packaging** **Dr. Alkim Akyurtlu & Dr. Joey Mead – Co-Chairs**
1:00	**“Beyond CMOS: Wafer Scale Heterogeneous Integration of III-Vs and Other Dissimilar Materials with Si CMOS to Create Intelligent Electronics/Micro-systems”, Dr. Thomas Kazior** – Raytheon Integrated Defense Systems, Andover, MA
1:25	**“Synthesis and Preparation of Sn/Ag Nanosolder Paste for Micro/Nano-Electronics Assembly and Packaging”, Evan Wernicki** – University of MA Lowell, Lowell, MA
1:50	**“Scalable Nano and Microscale Printing of Sensors and Electronics”, Dr. Ahmed Busnaina** – Northeastern University, Boston, MA
2:15	**“Packaging of MEMS for Aerodynamic Measurements”, Dr. Robert White** – Tufts University, Medford, MA
2:40	**“Thermogravimetric Study of Dicyandiamide for Application in CVD Growth Process of Single Layer Film of Graphitic Carbon Nitride (g-C_3N_4)”, Abdul M. Syed**, M.M. Masaki, C.M. Dragun-Bianchi, & J. Therrien **–** University of Massachusetts Lowell, Lowell, MA
3:00	**Refreshments & Raffles in the Exhibit Hall**

Morning Session	**Directors Room**
8:30 – 11:30	**Session C: SMT and Electronics Packaging** **Tina Barcley & Mike Martel – Co-Chairs**
8:30	**“Improving Electronics Assembly Process Through Organic-Metal Final Finish”, Dr. Rita Mohanty** – Enthone, Waterbury, CT
8:55	**“20 Year Shelf Life Study for Surface Finishes”, Gerard O'Brien**, D. Hillman – STandS Group, Richmond, KY
9:20	**“Flexible Electronics – Packaging Design”, Tina Barcley** – TAS Consulting, Mendon, NY
9:45 – 10:15	**Coffee Break in the Exhibit Hall**
10:15	**“System Level Technical Analysis for EO Sensors”, Michael Meier** – MJM & Associates, Rochester, NY
10:40	**“Applying New Approaches to Emerging SMT PCB Stencil Printing Challenges”, Michael L. Martel** – MMC Marketing, Bristol, RI
11:45 – 1:15	**Lunch & Keynote in the Exhibit Hall**

Exhibit Hall

Vendor Exhibit – Open All Day !

iMAPS New England Chapter

Employment Center

- Job Postings -

Located in the Registration Area

The New England Chapter

Exhibit Hall

Session H: Poster Session - Viewing All Day

Dr. Zhiyong Gu & Dr. Rita Mohanty – Co-Chairs

Authors Review 2:00 PM – 3:30 PM

“High-resolution Inkjet and 3D Printing”, Yang Gou – University of Connecticut, Storrs, CT

“Optical Approaches for Glucose Biosensing”, Jun Chen – University of Connecticut, Storrs, CT

“Screen-printed Electrode (SPE) based Solid-State pH Sensor”, Qiuchen Dong – University of Connecticut, Storrs, CT

“Fluorescent Carbon nano-particles (CNPs) for Explosive Sensing”, Sichen Zhang – University of Connecticut, Storrs, CT

“Protein Microspheres with Unique Autofluorescence for Non-invasively Tracking and Modelling of Their In Vivo Biodegradation”, Xiaoyu Ma – University of Connecticut, Storrs, CT

"Thermogravimetric Study of Dicyandiamide for Application in CVD Growth Process of Single Layer Film of Graphitic Carbon Nitride (g-C_3N_4)”, Michael Masaki – University of MA Lowell, Lowell, MA

“Novel 3D Vertically Aligned Platinum Nanowire Array as Electrocatalysts for Direct Methanol Fuel Cells”, Daniel Chuqing Liu – University of MA Lowell, Lowell, MA

“Melting Behavior and Morphology Change of Metallic Nanowires Using Femtosecond Laser Irradiation”, Jirui Wang – University of MA Lowell, Lowell, MA

“Counterfeit Component Prevention and Detection”, Scott Mazur – Benchmark Electronics, Nashua, NH

Exhibit Hall

Vendor Exhibit – Open All Day !

Geib Refining Corp.
Dependable Precious Metal Reclamation

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MSI
MINI-SYSTEMS, INC.

MRSI
SYSTEMS

GREEN
TJ GREEN ASSOCIATES, LLC

TECHNIC INC

Morning Technical Program

Session A: RF & Microwave - Innovations & Emerging Technologies
Chaired by Tom Terlizzi (GM Systems) & Dr. Tracey Vincent (CST)
Seminar Room - 8:30 AM – 11:30 AM

8:30 – 8:55 AM Seminar Room

"Investigation of Electromagnetic Field Coupling from DC-DC Buck Converters to Automobile AM/FM Antennas", Patrick DeRoy - CST, Framingham, MA

DC-DC buck converters are widely used in modern automotive applications due to their high power efficiency. However, they are also a major cause of electromagnetic emissions due to the nature of the fast switching voltages and currents. In modern automobiles there are as many as 24 antennas [2015], and the number will continue to increase in coming years. The close proximity of electronic modules and antennas create a complex electromagnetic environment. Hence computational electromagnetic field simulation tools are required to predict the EM interactions early in the product development phase. This paper examines the electromagnetic interaction of 500 kHz buck converter with AM band antenna by measurement and simulation. Vehicle level interference in the AM band resulting from the buck converter is measured and analyzed. A mitigation technique achieving more than 27 dB of EMI noise suppression is suggested and numerically examined.

8:55 – 9:20 AM Seminar Room

"**ECLIPS: Embedded Cooling Layer – Integrated Power System**", **Al Wasserzug** – Cirexx International, Louisville, KY

A System of Producing High-Power RF Circuit Boards Employing a Newly Developed, Thermally Engineered, Ceramic-Matched CTE Metalized Layer.

ECLIPS is a recently developed and patented technology for the fabrication of Printed Circuit Boards used primarily in high-power RF/millimeter wave applications. It involves the use of a thermally engineering metalized layer with superior thermal characteristics and a ceramic-matched CTE. The resulting Printed Circuit Boards allow the user to direct die-attach high-power RF die, such as GaA and GaN devices through a cavity in the outer core layer(s), directly to the thermal layer below; and then wire bond to the surface conductive layer. CTE (coefficient of thermal expansion) of the material allows for the reliable die-attach and wire bonding and the thermal characteristics quickly and efficiently evacuate the tremendous heat generated.

This technology is an alternative to co-fired ceramics and hybrid integrated circuits and replaces the need for bulky, heavy heat sinking schemes around the high-power devices. And since the item is essentially a Printed Circuit Board, made from otherwise common Printed Circuit Board materials, the electronic components on board that do not need to be bare die can be standard "plastic parts" attached in a standard SMT (surface mount technology) process such as a vapor phase. This results in an electronic system that is smaller, lighter weight, and certainly much less costly than the common alternatives.

9:20 – 9:45 AM Seminar Room

" High Dielectric Constant, Low Loss Additive Manufacturing Materials for RF/Microwave Applications", Caprice Gray, Andrew Dineen, Reed Irion, Alexandra Roach, Sarah Rappaport – Draper, Cambridge, MA

As part of Rapid Applied Materials and Processes (RAMP) IR&D Materials Thrust, we identified a goal of creating a universal printing material tunable electrical and/or mechanical. We are targeting printing this material on an additive manufacturing tool capable of mixing materials, such as the Connex Objet 260 available in Draper's Rapid Prototyping Lab. This tool is currently capable of printing modulus and color discretized gradients in 3 dimensions with commercial materials, but the materials are limited to only 14 different moduli and the electrical properties are largely unknown. These issues can be traced to both material and tool programming issues. More customizable additive manufacturing tools capable of mixing materials in specific ratios are just making their way to market now (Huang et. Al. 2015). One of these tools, which is yet to be identified for this work, would be capable of a custom mixing custom material that we design and printing them with a 3D gradient in electrical and/or mechanical properties.

The application space we targeted was high dielectric constant, *e*, low loss materials for RF/microwave because this field often struggles with shaping brittle high dielectric constant materials into complex form factors. We have added high *e* ceramic nanoparticles to an epoxy polymer matrix to create a polymer matrix composite (PMC). The approach to the materials design was a pretty classic approach that has been used to make dielectrics high frequency capacitor (Dang, 2012). However, it is only vary recently that high *e* PMCs have be converted into a form that is compatible with additive manufacturing to make functional mm devices (Friederich et. Al, 2015). This approach is extensible to other applications because other types of particles can be added to a similar polymer base to create variability in mechanical and physical properties of materials. Example applications include flame retardant layers added to ballistics or rocket nozzles, windows that can withstand thermal gradients for space applications, or controlled biodegradability for drug release devices (Hussain, 2006).

The ultimate demonstration we targeted was a 3D printed gradient index lens (GRIN) for focusing mm waves because smooth gradients with existing materials are difficult to achieve and the manufacturing processes to create these lenses are expensive and time consuming. GRINs have been created using additive manufacturing tools by adding porosity to a base polymer material (Allen, 2013; Laing 2013) This is not an effective way to make small devices because the *e* for plastics is typically below 5 (Dang, 2012). The ability to print gradients of high dielectric constant ceramics would enable smaller, more covert mm wave lenses. The target delivery date on this demonstration was the end of FY17. We will not be pursuing this effort beyond FY16 Q2, but we will discuss our progress to date in the text below.

This effort was started in Q1 FY16, so we will be reporting on 6 months of progress towards the goals described above. Our major accomplishments include:

- *Electrical Characterization of Additive Manufacturing Materials*: Characterizing dielectric constant and loss tangents of existing additive manufacturing materials available at Draper in both the kHz and GHz ranges.
- *PMC Materials Engineering*: Creating a material with high/tunable dielectric constant and low loss that can be molded into different form factors
- *Device Design and Test*: Creating and testing a dielectric waveguide from both printed and molded materials

9:45 – 10:15 Coffee Break in Exhibit Hall

10:15 – 10:40 AM Seminar Room

" How to Simulate RF Materials Considering Accuracy and Speed", Dr. Tracey Vincent - CST, Framingham, MA

Microwave engineers and signal integrity engineers designing high speed electronics need to accurately simulate materials for accurate results, particularly losses in their designs. Full-wave solvers offers sophisticated characterizing and parameterizing of materials for accurate simulation that accounts for both conductor and dielectric losses. This presentation will show features and strategies, and the theory behind them, that can help to create a straightforward workflow for fast and accurate results. A case study of a copper foil will show how multi-faceted this problem is and the many ways to approach it, including the ERD method which is a novel way of capturing surface roughness impact on insertion loss.

10:40 – 11:05 AM Seminar Room

" Addressing the Design Challenges of RF / Millimeter Wave Semiconductor Packaging", Craig Vieira, Ametek-ECP. New Bedford, MA

Ametek Electronic Components & Packaging (ECP) is the world leading producer of end to end electronic packaging solutions for harsh environments and reliability sensitive applications. Our primary markets employ a large level of RF through millimeter wave communication – in defense, aerospace, and optical communication. Ametek ECP has expanded the RF design engineering department to meet the growing market need for high performance integrated RF interconnects. The expanded portfolio will include press-fit connectors (SMP, SMPM, SMPS, etc.) designed for operating frequencies above 50GHz, as well as custom high speed, High Temperature Co-fired Ceramic (HTCC) interconnects, such as the patented S-Bend technology.

Expanded high performance measurement and 3D modelling and electromagnetic simulation capability addresses current and future I/O needs in both coaxial and ceramic arenas. Millimeter wave technology adds in unique challenges of physical design dimensions on the order of quarter wavelengths requiring sophisticated engineering, simulation, and testing capability, particularly in challenging environmental and high reliability applications.

11:05 – 11:30 AM Seminar Room

"Future of QML Hermetic ICs", Timothy J. Flaherty - Golden Altos Corporation, Milpitas, CA

QML hermetic ICs (Integrated Circuits) have historically occupied a corner of the electronics market where the low volume, stringent quality and irregular purchasing requirements have led to higher costs. Programs have often looked to use COTS (Commercial Off-The-Shelf) and/or upscreening parts in an attempt to reduce expenditures and meet budget requirements. Consequently, the death knell has been rung many times for QML hermetic ICs over the decades. Still, the market for these devices continues to thrive. Our talk will review the advantages QML hermetic devices offer and how their future remains solidly entrenched in the military and aerospace arenas.

Lunch 11:45 – 1:15 PM in Exhibit Hall

Session B: High Reliability Interconnects

Chaired by Mike McKeown (Hesse Mechatronics) & William Boyce (SMART Microsystems)

Cotillion Room - 8:30 AM – 11:30 AM

8:30 – 8:55 AM Colonial Room

"Heavy Copper Wire Bonding for Mass Production", Mike McKeown, Michael Brökelmann, Dirk Siepe, Matthias Hunstig, Kris Oftebro, Hesse Mechatronics, Inc., Mineola, NY

Copper wire as a bonding material for the top side connection of power semiconductors is highly desired. One current drawback in heavy copper wire bonding is the relatively low lifetime of the consumables. The bonding tool wear mechanisms and the corresponding factors are investigated. To reduce wear, different approaches are tested in long-term bonding tests. Optimized bonding tool tip geometry and tool material are two of these factors. Optimized bonding parameters were investigated as well and show a significant improvement in bonding tool lifetime. Wear and lifetime of the cutter and the wire guide are also examined. Additionally, the impact of bonding tool wear on different aspects of bond quality is addressed. It is also shown how wear can be monitored by machine process data recording and how a derived signal correlates to the actual wear status. These major advances in heavy copper wire bonding now make it a robust, reliable and efficient interconnection technology.

8:55 – 9:20 AM Colonial Room

"Understanding the Role of Ultrasonic Welding in Wire Bonding", Lee Levine – Process Solutions Consulting, Inc., New Tripoli, PA

Wire bonding is a high-speed ultrasonic welding process that is the dominant chip interconnection method. More than 15 trillion wires are bonded annually. Ultrasonic energy is the principal process parameter affecting the deformation of the ball and the bond pad or substrate. Deformation of both the ball and the bond pad are required to form the intermetallic weld. Understanding of the process and the effect of ultrasonic energy on the deformation behavior of the materials is a key to achieving high-yield, high-reliability interconnections. This paper will discuss the role of ultrasonics in the deformation of a material and its relationship to weld formation. It will also explain a number of key machine dependent variables such as ultrasonic frequency and control mode (constant voltage versus constant current modes) and their relationship to weld formation.

9:20 –9:45 AM Colonial Room

“Configurations for Robust Gold Stitch-to-Substrate Wire Bond Attachment”, William Boyce – Smart Microsystems, Elyria, OH

Gold wire bond attachment is a standard manufacturing process commonly used for high reliability applications due to the robust nature of the gold ball bond process on gold pads. The ball bond attachment method, typically used to make the first connection to the silicon die, is on one side of the wire where a stitch bond is used to make the wire attachment on the other side therefore electrically connecting the die to the substrate/package. Defining the process window for the stitch-to-substrate bond is more challenging as there are conditions that have a greater influence on the bond quality such as ability to apply heat, composition/quality of pad metal, and cleanliness. Adding a ball to the stitch bond can overcome the adverse effects of conditions that may not otherwise be properly controlled. Two common bump additions to the standard stitch bond are SSB and Security Bump. Previous work suggests security bumps to be more robust after 300 cycles of thermal shock. Utilizing new and more advanced equipment paired with a longer testing period, the three bond types were reevaluated. Wire pull and ball shear testing before and after thermal cycling were used to compare the bond strength and reliability of the three different stitch-to-substrate bond configurations.

9:45 – 10:15 Coffee Break in Exhibit Hall

10:15 – 10:40 AM Colonial Room

“Process Optimization on Advanced Al Wirebond Tools”, Matthew Kurtz - Rochester Electronics, Newburyport, MA

With the newest generations of Al wire bonders on the market, new setup parameters have been added to allow for more advanced and reliable wire bonds. These additional process variables can make process optimization difficult. Power, force, time, and loop height are no longer the only tools available to process reliability. In this presentation example results will be presented showing the methodology used to optimize a wire bond process on a Hesse BJ820 at Rochester Electronics in Newburyport, MA. A review of the main process effects of power, time, and force on pull strength will be reviewed. In addition, a study of more advance process parameters effect on bond quality will be undertaken.

10:40 – 11:05 AM Colonial Room

“Submicron Au Particles for Low Temperature Au to Au Bonding”, William (Bud) Crockett, Tanaka Kikinzoku Kogyo K.K., San Jose, CA

This paper will introduce low temperature bonding of conductive materials and will include: epoxy base resin, Sn solder, AuSn solder, sintered Au and sintered Ag. It will discuss the sintering behavior of sub-micron Au particles. A comparison of the properties of AuSn solder and Au sub-micron material will be reviewed. In addition, the storage as well as use-age will be addressed (needle dispensing, daubing and flip chip bumping). Examples of this material in microelectronic applications will be shown for LED, SiC, MEMS hermetic sealing and wafer-to-wafer bonding.

11:05 – 11:30 AM Colonial Room

“Wire Bonding onto Niobium for Superconducting Applications”, Dr. Michael Hamilton - Auburn University, Auburn, AL; & Mike McKeown - Hesse Mechatronics, Inc., Mineola, NY

Niobium is a relatively new metal utilized in wire bonding applications. This presentation will review the challenges of wire bonding onto such a metal as well as the process issues. Wire bonding onto a Nb metallization has its own set of characteristics as it is unlike the structure of Al. In-depth review of visual, wire pull and bond shear testing of 10 mil 99.99% Al wire will be discussed for Nb surfaces as well as to Nb that had Al and Au top metallizations. Reliability testing was not yet completed but will be addressed.

Lunch 11:45 – 1:15 PM in Exhibit Hall

Session C: SMT and Electronics Packaging
Chaired by Tina Barcley, (TAS Consulting) & Mike Martel (MMC Marketing)
Directors Room - 8:30 AM – 11:30 AM

8:30 – 8:55 AM Directors Room

“Improving Electronics Assembly Process Through Organic-Metal Final Finish”, Rita Mohanty – Enthone, Waterbury, CT

Final finishes used in the industry today includes both organic and metallic finishes. It is critical to understand the effects of various final finishes on the fabrication, assembly, and most importantly the solder joint reliability before choosing a final finish. This paper present the results from a series of statistically designed experiment to understand the interaction of surface finish with different lead-free solder paste on assembly reliability.

8:55 – 9:20 AM Directors Room

“20 Year Shelf Life Study for Surface Finishes”, Gerard O’Brien, David Hillman – STandS Group – Richmond, KY

Printed circuit board surface finishes are generally acknowledged of retaining their solderability characteristics for 1-2 years dependent on their storage conditions and original deposition quality. But what happens to printed circuit board surface finishes after being stored for 20 years? This paper documents a unique situation where industry printed circuit boards surfaces finishes were examined using wetting balance assessment and electron microscopy analysis after being stored in 21C, 30%-70% RH conditions. Some of the printed circuit board surface finishes included in the investigation were immersion silver, immersion bismuth, ENEPIG and ENIG.

9:20 – 9:45 AM Directors Room

“Flexible Electronics – Packaging Design”, Tina Barcley – TAS Consulting, Mendon, NY

Flexible Electronics have been around for a while, but are advancing tremendously due to the technology needs of several industries. They have changed significantly in what materials are being used, the expected reliability (which is awesome), and are making new technologies like “wearables” and “touch-screen products” grow incredibly fast. Everything you ever saw in “The Jetsons” is happening. Industries that use flexible electronics include: Medical, Wearable Consumer Products, Aerospace & Aeronautical, Outdoor Applications, Automotive, Laboratory Equipment, and General Electronics. Products include, multilayer circuits, flexible heaters, rigid – flex combinations, optical circuits, LED circuits, touch-screen interfaces, and shielding. All the above industries and products will be covered to identify risk areas and special areas of concern.

9:45 – 10:15 Coffee Break in Exhibit Hall

10:15 – 10:40 AM Directors Room

“System Level Technical Analysis for EO Sensors”, Michael J. Meier – MJM & Associates, Rochester, NY

Electro Optical Sensor Systems have been around for over seven decades. While the ingredients of a successful system have not changed, use of ever advancing technology allows improvements in size, weight, power, performance, and cost. A user can tailor simple modular EO systems such as digital cameras, but a new satellite payload may have over 600 parameters to consider. An overview of EO sensor system development will be presented with examples from a smart phone camera to the Hubble Space Telescope.

10:40 – 11:05 AM Directors Room

“Applying New Approaches to Emerging SMT PCB Stencil Printing Challenges”, Michael L. Martel – MMC Marketing, Bristol, RI

Current trends in the production of mobile consumer electronics and automotive products are driving the SMT stencil printing process to achieve higher throughputs with correspondingly higher wet print accuracies. Process challenges are imposed by such as larger (panelized) PCB handling requirements, shrinking PCB topographies with smaller components and tighter designs (fine pitch), and the demands of 'broadband printing'. Printer suppliers are responding to these issues with new and enhanced techniques that improve volume distribution and print definition, holding the print process window open. For example, more printers use side-clamping systems for more accurate test results and fewer volumetric variations across the board. Also, the ability to adjust squeegee angle has improved print consistency from edge to edge and increased the aperture fill on experimental materials, something that we are seeing more and more of as PCB assembly technology advances into new territories. These are some of the issues that will be briefly discussed in this paper.

Lunch 11:45 – 1:15 PM in Exhibit Hall

Session D: Printed Electronics

Chaired by James Zunino III (ARDEC) & Katherine Duncan (CERDEC)

Colonial Room - 8:30 AM – 11:30 AM

8:30 – 8:55 AM Colonial Room

"Application of Inkjet Printing Technology", Michael Carr, Y. Gu, & J.F. Federici - Department of Physics, New Jersey Institute of Technology, Newark, NJ

Printed circuits, sensors, electronics and radio frequency identification tags via liquid-based "ink" have received increasing interest in recent years. By using the functional fluid, inkjet printing technology is a promising method to deposit patterned metallic thin film structures on polymer substrates for use as electrical contacts, circuit elements or sensory elements. Our laboratory has specialized in development of new inks as well as standardization of the ink's physical parameters to ensure reliability and reproducibility of the printed structures. We have developed a particle-free silver ink with superior electronic properties which is suitable for printing. Due to the absence of particles, the particle free silver ink will not clog an inkjet printer nozzle in most applications. Constantan ink is also developed which has excellent potential in mechanical sensing applications. Using a designed chemical process, stable constantan ink is formulated and constantan patterns are fabricated by inkjet printing. The growing demand for inkjet printing has lead to a large number of available inks, each with varies properties and compositions. It has been our goal to develop a system of tests and measurements, in order to determine properties of inks – both commercially available or developed in our laboratory – which can be used as metrics for predicting ink performance. The system of tests and measurements enables us to create a database of inks and their properties, so that in the future, it will be easier to identify alternative inks for specific applications. [1]Funding support provided by Picatinny Arsenal, AMRDEC

8:55 – 9:20 AM Colonial Room

"Electrical Characterization of Traditional and Aerosol Inkjet Printed Conductors under Tensile and Strain", Jake Rabinowitz – Northeastern University, Boston, MA**;** G. Fritz, M. Miller, P. Lewis, P. Kumar, A. Dineen, C. Gray – Draper, Cambridge, MA

Emerging additive manufacturing fabrication methods offer promising alternatives to traditional rigid manufacturing tooling and processing for the nascent field of flexible hybrid electronics (FHE) (Nathan et al., Proc. IEEE 100, 2012). Additive manufacturing techniques allow for rapid design prototyping (Vaezi et al., Int J Adv Manuf Tech, 2013) and, more recently, incorporation of novel materials into complex device geometries (Kim et al., ACS Appl. Mater. Interfaces, 2013; Folgar et al., Mater. Lett.,2011) . One specific additive manufacturing technique is aerosol inkjet printing, which can precisely deposit any aerosolizable bulk material onto a variety of surfaces – curved, rigid, flexible, nonuniform, elastic, and hybrid (Adams et al., Electron. Lett, 2015). We have investigated the properties of aerosol inkjet printed conductors, specifically silver micro flake and CNT inks, on PDMS and compared them to more conventional sputtered copper and evaporated silver traces.

There are no specific IPC, ASTM or MIL standard characterization techniques for flexible and stretchable devices (DoD FOA-RQKM-2015-0014), though some initial work has been done to adapt these standards to flexible products [Continued on page 22]

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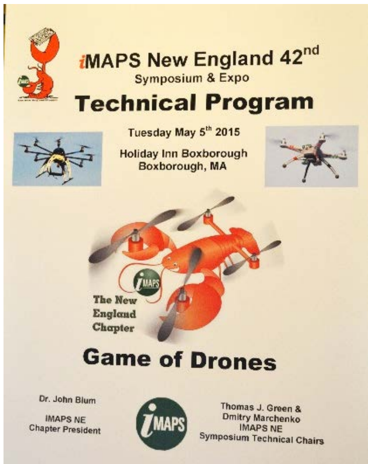
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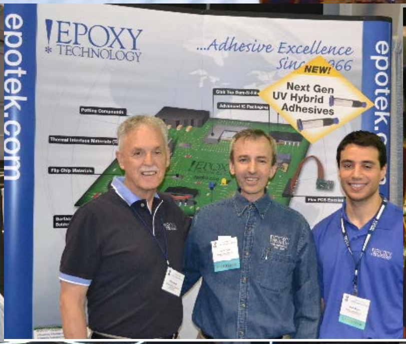

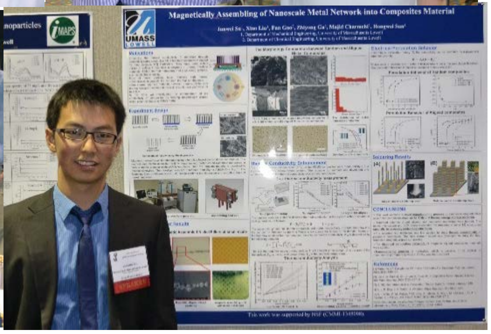

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(IPC-TM-650, # 2.4.3). We have developed a material-agnostic set of mechanical tests for FHE that are characterized by performance in response to tensile and flexural strains. These metrics apply the critical aspects of industry standards for adhesion (IPC-TM-650, #2.4.1.6) and electrical performance (ASTM F1711-96) of conventional electronics to soft dielectric conductor pairings. The electrical properties and interfacial adhesions of sputtered and evaporated metals on PDMS have been characterized under single and cyclic flexural and tensile strains up to 50% and compared to the performance of aerosol inkjet printed materials. Determination of the relative elasticities and critical strain limits of the various conductors will qualify the suitability of traditional and novel materials and methods to FHE platforms, such as implantable biosensors, conformal RF communication systems, wearable electronic devices, zero-stress chip packaging, and more.

9:20 – 9:45 AM   Colonial Room

"Fully Printed Conformal Antenna and Sensors on 3D Plastic, Ceramic, and Metallic Substrates", Mike O'Reilly - Optomec Inc., Albuquerque, NM

There is a growing demand for antennas and sensors directly integrated into products including smartphones, wearables, structural components, and IoT related products. Creating integrated 3D antenna and sensors using a direct write approach enables rapid product design and prototyping, reducing the number of manufacturing steps, while broadening the choice of substrate materials. Aerosol Jet® technology is used to print a wide variety of materials, including conductive and ceramic inks suitable for antenna and sensor creation. Material considerations will be discussed, and case studies involving broadband, Bluetooth, NFC antenna, plus strain and creep sensor comparisons between Aerosol Jet and traditional fabrication methods will be presented. Examples of via filling and wrap-around printing using five axis of motion manufacturing solutions will be discussed.

9:45 – 10:15 Coffee Break in Exhibit Hall

10:15 – 10:40 AM   Colonial Room

"Next Flex - Flexible Hybrid Electronics Manufacturing Innovation Institute", James Zunino III – U.S. Army RDE Command (ARDEC), RDAR-MEE-M, Picatinny Arsenal, NJ

In August 2015, the Department of Defense announced a $171M Cooperative Agreement with FlexTech Alliance to establish a Flexible Hybrid Electronics (FHE) Manufacturing Innovation Institute, subsequently named NextFlex. Based in San Jose, CA, the mission of NextFlex is to catalyze a domestic manufacturing ecosystem in FHE, with an initial focus in human performance monitoring/wearable medical devices, structural health monitoring, wideband array antennas, and soft robotics. The presentation will emphasize NextFlex's five manufacturing focus areas, which include device integration & packaging, materials, printed flexible components & microfluidics, modeling & test, and standards, testing, and reliability.

Established as a public-private partnership, NextFlex brings together resources from the federal government, state and local governments, companies, universities, and non-profit entities to enable state of the art manufacturing technology for areas critical to both the military and commercial sectors in the United States. The Institute will execute project calls in which its company and university members partner to advance the technology and manufacturing readiness levels (TRLs and MRLs) related to its mission. With a TRL/MRL entry point of 4, NextFlex aims to leverage the R&D investment at federal labs, universities, and companies by maturing select technologies to TRL/MRL 7, at which point they are commercially viable. NextFlex also includes an education and workforce development initiative, with goals of training and retraining a domestic workforce in FHE manufacturing, which includes K-12 STEM outreach efforts, the development of curricula in 2-yr, 4-yr, and graduate programs, and tools for companies to retrain their existing workforce. NextFlex is also standing-up a hub facility in San Jose, CA, which will provide members and non-members access to state-of-the-art FHE manufacturing and characterization facilities as well as the opportunity for prototyping or low-volume manufacturing services.

The first NextFlex projects are expected to be awarded in early 2016 and will be discussed during the presentation. Approx. $5M will address manufacturing challenges related to the packaging and integration of sensors for personal health and asset monitoring devices. Each project is expected to bring together an industrial-academic team, which will provide at least 1:1 cost share for the DoD funds. An update will also be provided on the Institute's Education & Workforce Development Initiative and on the status of prototyping and low-volume manufacturing hub. Finally, the

NextFlex roadmap process will be discussed, with a description of how NextFlex's investment strategy is determined, including upcoming project call opportunities.

10:40 – 11:05 AM Colonial Room

"America Makes and Status of Research in Multi-Functional Printing", Dr. Eric MacDonald - Univ. of Texas, El Paso, TX

Additive manufacturing, also called 3D printing, has captured worldwide attention. Many believe that it is introducing the next industrial revolution because of its impact on product innovation and its unique manufacturing capabilities. America Makes, the National Additive Manufacturing Innovation Institute is the first Manufacturing Innovation Institute established as part of a National Network for Manufacturing Innovation. Dr. Eric MacDonald, Associate Director of the W. M. Keck Center for 3D Innovation, The University of Texas at El Paso (UTEP) will give an overview of additive manufacturing, and will discuss America Makes' actions to accelerate the use of additive manufacturing technologies in the United States and increase our nation's global manufacturing competitiveness. He will also provide highlights of the Multi3D Manufacturing project on-going at UTEP.

11:05 – 11:30 AM Colonial Room

"SuperScrypt - Next Generation Additive Manufacturing System", C. Mike Newton – Sciperio / nScrypt, Orlando, FL

The US Army and nScrypt have partnered to design and develop a next generation Additive Manufacturing System, "SuperScrypt", with expanded upon nScrypt's standard 3Dn Series gantry system. In addition, tool changing was added to allow the multi-material, multi-function capability. This multi-technology printing system integrates process controls, multi-axis manipulation, numerous fabrication, inspection, and scanning capabilities. Utilizing the patented SmartPump™ technology, this system can print very low viscosity inks to extremely high viscosity pastes to allow the widest range of electronic materials to be printed. The system also includes nFD™ thermal plastic extruder, capable of thermal plastic and composite thermal plastic objects from a 1.75 mm filaments. The system allows for complete fabrication so you can "Print what you can, and place what you can't!", thus providing a complex manufacturing solutions. While many groups are talking about heterogeneous potential and developing a printer that is capable of mixing structures and electronics. With Scan-to-print capability, the SuperScrypt can deposit on complex curves, or build 3D shapes from scan data. Inverse kinematics enabled 6-axis motion control allows for true 3D printing instead of stacking 2D layers. Robust hardware allows for +/- 100nm precision. The tool has the widest range of material options available for any printed electronic tool. There are more than 10,000 commercially available materials that can be utilized. Feature sizes range from as small as 20 microns to as large as millimetres. Material properties range from conductors, resistors, dielectrics and even materials with permeable properties. The nScrypt tool is printing silver, gold, platinum, copper, nickle and alloys as part of the metal printing process. A number of dielectrics to include ceramic and polymer are also printed. Additionally, resistors are standard prints for this tool. The Army has successful used the SuperScyrpt for Fuze components, munitions systems, antennas, prognostics and diagnostics, High-G circuitry, embedded sensing, and numerous other applications to support current and future projects and programs. The system has also allowed for revolutionary improvements for the integration of Flexible Hybrid & Printed Electronics with 3D structures. With the multi-material capabilities and the addition of pick and place, this tool has exceeded standard prints making complex Phased Array Antennas, Munitions Sub-systems, Fuze Components, and Unmanned Systems possible, proven and functional. The system will be described as well as how it is being utilized to develop integrated, printed Fuze Components and Sub-systems for DOD applications.

Lunch 11:45 – 1:15 PM in Exhibit Hall

Keynote Lunch Address

“Trillion Sensors for Health Care”

Presented by Dr. Ahmed A. Busnaina – NSF Nano Center Director at NEU

12:15 – 12:45 – Exhibit Hall

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Afternoon Technical Program

Session E: Medical Device Packaging

Chaired by Steve LaFerriere (Yole Developpment) & Tom Green (TJ Green Associates LLC)

Cotillion Room - 1:00 PM – 3:05 PM

1:00 – 1:25 PM Cotillion Room

"Hermetic Packaging of Implantable Devices: How did we get here? And where are we going?", Heather Dunn – Cirtec Medical, Longmeadow, MA

Hermetic packaging protects the active electronic components of implantable devices from body fluids and in some cases protects the body from materials present in the electronics. This talk will review the evolution of hermetic packaging for active implantable devices, outline new device technologies that are driving changes to traditional hermetic architectures, and look forward to potential future approaches to hermetic packaging.

1:25 – 1:50 PM Cotillion Room

"A Transistor-less, Wireless Neural Implant", Daniel Freeman – Draper, Cambridge, MA

Wireless neural stimulators are being developed to address problems associated with tethered implants, including scar tissue growth and lead breakage. However, designing wireless stimulators on the sub-millimeter scale (<1mm3) is challenging because as device size shrinks, it becomes difficult to deliver sufficient wireless power to operate the device. Here, we present a novel design for a sub-millimeter, inductively powered neural stimulator consisting of a coil to receive power, a capacitor to tune the resonant frequency of the receiver, and a diode to rectify wireless signal to produce a DC current to excite neurons. By not including transistors in the design, we have reduced the required voltage levels that are needed to operate the device from 1 - 2V to approximately 0.25 – 0.5V. This reduced voltage requirement allows us to achieve smaller device size than previously reported stimulators. The device is designed to operate across a large range of distances, including in deep brain tissue (>5cm depth). Furthermore, each stimulator can be individually addressed by tuning the resonant frequency of the device, allowing multiple sites of stimulation.

1:50 – 2:15 PM Cotillion Room

"RF Companion Chip Based on PICS Technology for Small and Reliable Medical Device Packaging: Application to Ultra-Low Power RF Implants", Mohamed Mehdi Jatlaoui – IPDiA, Caen Area, France

This work presents a new way for packaging RF-linked implants based on silicon IPD with low profile, high reliability and high degree of integration while keeping very good performance of the communication link both for the wake-up signal and in-body data communication. Commonly, the communicating implant is composed of a dual band RF transceiver (MICS 402-405 MHz and ISM 2.4GHz) mounted on a PCB with SMD decoupling capacitances, crystal oscillator, SAW filter and different matching networks. The performances of the communication link are directly related to the electrical parameters of these components and the way they are connected to each other. This new packaging technique is based on functionalized silicon Passive Integration Connective Substrate (PICS): all the components are integrated within the IPD except the transceiver, the crystal oscillator and the SAW filter. The IPD integrates 3D trench capacitors for the decoupling purpose and the different RF paths (matching networks, DC blocks) for both MICS and ISM band. The matching networks are composed of inductors and MIM capacitor structures connected together using thick copper metallization layer to increase inductors quality factor and reduce ESR. All the passive components are embedded within the silicon substrate and thus we suppress all the reliability problems related to mounted SMD components. Then, the silicon integrated passive device is mounted on multilayer PCB interposer to be connected to the bare die transceiver.

A detailed description of the RF module package is given. The benefits of such packaging technique are highlighted. Finally, RF simulation results will be presented and compared to the RF module measurements.

2:15 – 2:40 PM Cotillion Room

“Packaging Architecture for an Implanted System that Monitors Brain Activity and Applies Therapeutic Stimulation”, Caroline Bjune – Draper, Cambridge, MA

Deep brain stimulation therapies for Parkinson’s disease utilize hardware, which from a packaging perspective, resembles that used in cardiac pacemakers. A hermetic package that contains stimulation electronics and a primary battery supply is implanted under the scalp in a recess cut into the skull. Stimulation probes, each with up to four electrodes, are inserted into the brain and connected to the electronics package via a plug and cable system. By contrast, the closed loop neural stimulator being developed under the DARPA SUBNETS program utilizes probes, which each carry up to 64 electrodes that can be switched between recording and stimulation functions. This capability necessitates locating low noise amplifiers, switching and communication electronics in close proximity to each probe. Each of these satellite electronics packages requires ten electrical connections to the hub package, which significantly increases the complexity of the interconnect system relative to current practice. The power requirements of this system preclude the use of a primary battery supply so instead, a large lithium ion battery is used with a recharging coil and electronics. The hub system is fabricated as a separate connector header, electronics package and battery pack that are interconnected by a flex circuit to allow it to conform to the skull for implanting. In this paper, we will describe the various packaging components of the system and the design considerations that drove our technology choices.

2:40 – 3:05 PM Cotillion Room

“Electronics Packaging Methods and Materials for Implantable Medical Devices”, Susan Bagen – Micro Systems Technologies, Inc, Mesa, AZ

Electronics packaging for complex medical devices demands innovation and advanced capabilities, but achieved in a manner which ensures reliability and performance. The evolution of "smart" systems is driving complexity with integration of logic, memory, signal processing, biosensors, power and wireless connectivity. For implantable, wearable and portable devices, miniaturized and unique form factors require innovative size, weight and power (SWaP) reductions. This paper provides an overview of requirements and applications of smart medical devices. Advanced electronic packaging options that can support complex integration in miniaturized, atypical form factors are discussed. Flexible 3D interconnects that can accommodate folded, nested and/or rolled form factors, as well as custom stacked die ball grid array (SDBGA) packages are presented. The development of biocompatible material constructions incorporating liquid crystal polymer (LCP) and noble metals for direct implants is also discussed.

Session F: 3D and Beyond
Chaired by Maria Durham (Indium Corp.) & Dr. A.F. M Anwar (UConn)
Seminar Room - 1:00 PM – 3:05 PM

1:00 – 1:25 PM Seminar Room

“Room Temperature Fast Flow Reworkable Underfill for LGA”, Dr. Wusheng Yin – YINCAE Advanced Materials, LLC, Albany, NY

With the miniaturization of electronic device, Land Grid Array (LGA) or QFN has been widely used in consumer electronic products. However there is only 20-30 microns gap left between LGA and the substrate, it is very difficult for capillary underfill to flow into the large LGA component at room temperature. Insufficient underfilling will lead to the loss of quality control and the poor reliability issue.

In order to resolve these issues, a room temperature fast flow reworkable underfill has been successfully developed with excellent flowability. The underfill can flow into 20 microns gap and complete the flow of 15mm distance for about 30 seconds at room temperature. The curing behavior, storage, thermal cycling performance and reworkability will be discussed in details in this paper.

1:25 – 1:50 PM Seminar Room

"Beyond Chip Stacking: Quilt Packaging Enabled 3D Systems", Jason Kulick – Indiana Integrated Circuits, LLC, South Bend, IN

Quilt Packaging is an edge interconnect technology for direct chip-to-chip integration. Quilt Packaging (QP) utilizes solid metal structures that protrude from the vertical sidewalls of chips and/or interposers, acting as both an electrical and mechanical interconnect. Electrically, Quilt Packaging performs as if it were an on-chip interconnect, demonstrating less than 1 dB insertion loss across the entire bandwidth from DC to 220 GHz. Mechanically, Quilt Packaging enables sub-micron chip-to-chip alignment accuracy and can also be completely customized for I/O ranging from 10 micron pitch to structures that measure in the hundreds of microns. QP technology can be implemented in variety of material and process technologies to enable true heterogeneous integration in planar and unique 3D configurations beyond chip stacking. Applications such as VCSEL integration, curved focal plane arrays and unique system miniaturization concepts enabled by Quilt Packaging will be discussed.

1:50 – 2:15 PM Seminar Room

"Challenges Facing Electrochemical Deposition in Wafer Level Packaging", Thomas Richardson – MacDermid Enthone Electronics Solutions, Waterbury, CT

Unlike Damascene where solutions are presented for one node at a time, wafer level packaging (WLP) deals with numerous aspect ratios, wafer pitches, and pattern densities at any given moment. Often, the end user wants to use an all purposed chemistry. From this platform, all of the followings would be electroplated: RDL, microbumps, conventional pillars, and macrobumps for fan out technologies. In this manuscript, there will be discussions of the technical challenges for each of these processes. We will look at the role of accelerator and suppressor on nucleation density, and how that varies across bump dimensions. Most importantly we will show the relevance of levelers on bump uniformity and its direct correlation to the Wagner number. Furthermore, we will present electrochemical methods to understanding the factors that affect deposition rate, within die uniformity (WID), bump shape (dished-flat-domed), and Kirkendal voids at the microscopic level. Finally, we will show practical solutions to address each and every market segment.

2:15 – 2:40 PM Seminar Room

"Liquid Metal Interconnects for Conformable Sensor Packaging Enabling Inertial Measurements of Animals and Soft Robots", Nikolas Kastor, R.D. White - Tufts University, Dept. of Mechanical Eng., Medford, MA

In biomechanics, inertial measurements units (IMUs) are used to map the dynamic modes and gates of locomotion of animals. Typically, thin wires are soldered to the IMU and the package is bonded to the location of interest, on the animal, using cyanoacrylate or epoxy. These types of adhesives and the solder of the interconnects are brittle and typically fail from cyclic loading of the animal flexing its body. The same situation can be found in soft robotics, where a compliant and durable way of connecting electrical components within the body of the robot is required to maintain its "soft" characteristics. To solve this problem, we propose a self-contained package, which encapsulates an IMU, made from a flexible elastomer with room temperature eutectic metal interconnect "wiring." Because of the compliant nature of the materials used, the electronics package can then be bonded to a flexible surface with van der Waals forces. Using eutectic metal allows for compliant interconnects that will not break or change their resistivity under large strains. The electrical connections between the solder pads of a 3x3x1mm IMU are bridged to the required capacitors in 100x50µm microfluidic channels. 88µm diameter wires that exit the package to measurement electronics are attached by submersion of their stripped conductor in 300µm diameter wells. A positive pattern for molding the microfluidic system was manufactured by standard SU-8 photolithography on a Si chip where the IMU, capacitors and wires were placed on specific features of the micro-channels and encapsulated and filled with liquid metal.

2:40 – 3:05 PM Seminar Room

"Printed Transceiver Circuit for System-on-chip Sensor and Processor", Peter H Lewis – Draper, Cambridge, MA

This research employs aerosol jet printing to rapidly manufacture a multilayer PCB with COTs component integration. Specifically, this research provides a method to making a system-on-a-chip (SOC) circuit on a variety of substrates with novel integration methods. This fits well into the recent research phenomenon deemed “the internet of things.” By advancing the manufacturing capabilities for a system that can measure and transmit data, one can integrate such circuits with minimal spatial and geometric interference to the broader device. A unique manufacturing process was developed for non-embedded components which involves the building up of the circuit around the system’s microprocessor. The transceiver circuit and its microprocessor, based off a commercially available circuit, has been successfully programmed and has shown to be working. The matching network is still being worked on, however, the goal is to have it working by the conference. To the best of the researchers’ knowledge, this research is novel in that it is the most complicated multilayer circuit that has been built using aerosol jet printing technology. Rapid ageing tests for a silver and a CNT ink were done and analyzed to determine the reliability of an aerosol jet printed circuit board. Results show adhesion is the primary mechanism of device failure as opposed to conductor degradation.

Session G: Nanoelectronics & Optoelectronics Packaging

Chaired by Dr. Alkim Akyurtlu (Univ. MA Lowell) & Dr. Joey Mead (Univ. MA Lowell)

Colonial Room - 1:00 PM – 3:05 PM

1:00 – 1:25 PM Colonial Room

“Beyond CMOS: Wafer Scale Heterogeneous Integration of III-Vs and Other Dissimilar Materials with Si CMOS to Create Intelligent Electronics/Micro-systems”, Thomas E. Kazior – Raytheon Integrated Defense Systems, Andover, MA

Advances in silicon technology continue to revolutionize microelectronics. However, Si cannot do everything, particularly for high performance, high frequency RF and mixed signal applications. As a result circuits based on other materials systems, such as III-V semiconductors, are required. However, these other device technologies do not enjoy the integration density, cost benefit and manufacturing infrastructure of Si. So how can we get the ‘best of both worlds’? What is the best way to integrate these dissimilar materials with Si? In this paper, we review different heterogeneous integration approaches and, as an example, summarize our results on the successful wafer-scale, 3D heterogeneous integration (3DHI) of GaN HEMTs and Si CMOS.

Our Au-free GaN HEMTs have been successfully fabricated entirely in a Si foundry on semi-standard, 200 mm diameter Si wafers using Cu damascene interconnects. RF performance compares favorably with GaN on SiC devices fabricated in a III-V foundry with Au-based contact and interconnect metallurgy. Oxide bonding is being used to integrate these GaN on Si wafers with Si CMOS wafers. Through-dielectric-vias (TDVs) are used to interconnect the high performance GaN RF devices/circuits with high density CMOS control and logic circuits, resulting in ultra-short, wide-bandwidth interconnects and enabling circuit optimization through intimate and arbitrary placement of CMOS logic and control circuitry relative to III-V devices. Through-substrate-vias (TSVs) are used for thermal management. This ‘flexible’ wafer-scale, integration platform is compatible with other III-V devices, other (non-Si) device/component technologies and any node of Si CMOS or SiGe BiCMOS. The 3DHI process is being used to fabricate cost effective, high performance, digitally enhanced, RF and mixed signal ICs such as ‘intelligent’ and adaptive/reconfigurable transceivers.

Thus, heterogeneous integration of III–V devices, MEMS and other dissimilar materials with Si CMOS enables a new class of high-performance integrated circuits that enhance the capabilities of existing systems, enable new circuit architectures and facilitate the continued proliferation of low-cost micro-/nano-electronics for a wide range of applications.

1:25 – 1:50 PM Colonial Room

“Synthesis and Preparation of Sn/Ag Nanosolder Paste for Micro/Nano-Electronics Assembly and Packaging”, Evan Wernicki – University of MA Lowell, Lowell, MA

Solder pastes are widely used in electronics manufacturing processes for joining components to printed circuit boards (PCBs). With smaller component and packaging footprints paving the way, the need for smaller and more reliable materials is increasing. Synthesized using an aqueous chemical reduction method, Sn/Ag nanoparticles were characterized via SEM, TEM, XRD and DSC. Reports have shown that introducing nanomaterials into bulk solders can increase the mechanical strength of the solder joint systems. Here, the synthesized Sn/Ag alloy nanoparticles were introduced into micro-sized solder powders to form a composite solder paste structure. Shear strengths of the reflowed solder pastes were measured to study the effect of the nanoparticle additions. Our preliminary results show that the amount of nanoparticles mixed in solder pastes can increase the mechanical strength of the reflowed solder joints. Wettability and intermetallic compounds formed with the Cu substrate were also studied.

1:50 – 2:15 PM Colonial Room

"Scalable Nano and Microscale Printing of Sensors and Electronics", Dr. Ahmed A. Busnaina – Northeastern University, Boston, MA

The NSF Center for High-rate Nanomanufacturing (CHN) has developed a new fully automated system that uses directed assembly based printing at the nanoscale to make products that fully take advantage of the superior properties of nanomaterials. The Nanoscale Offset Printing System (NanoOPS) can print metals, insulators and semiconductors (including III-V and II-VI), organic and inorganic materials into nanoscale structures and circuits (down to 20 nanometers). The fully automated robotic cluster tool system prints at the nanoscale to make products that take full advantage of the superior properties of nanomaterials. The NanoOPS has been used to print utilizing the following nanomaterials: nanoparticles, nanotubes, nanowires, 2D materials and polymers. The center has many applications where the technology has been demonstrated. The Center has shown a new way to print interconnects on any substrate as well as transistors and invertors using carbon nanotubes and 2D materials. The center has developed many sensors, among them a biosensor chip (0.02 mm) capable of detecting multiple biomarkers simultaneously (in vitro and in vivo) with a detection limit that's 200 times lower than current technology. In addition, the center made a printed Band-Aid sensor that could read glucose, urea and lactate levels using sweat. An inexpensive micro chemical sensor with a low detection limit that's less than 1 mm in size has also been developed.

2:15 – 2:40 PM Colonial Room

"Packaging of MEMS for Aerodynamic Measurements", Robert D. White[1], P. Lewis[1,2], & B. Smith[2] **–** [1]Tufts University, Department of Mechanical Engineering, Medford, MA; [2] Draper, Cambridge, MA

Micromachined arrays of microphones and surface shear sensors have been packaged for aerodynamic flow testing applications. This application requires low surface topology for the entire package, as the boundary layer flows have a viscous sublayer thickness on the order of 25 microns. Ideally, the topology of the sensor array surface should be kept within the viscous sublayer in order to minimize the impact of the sensor on the characteristics of the flow. A variety of packaging approaches to this problem will be described. The first approach uses CPGA packages with CNC milled epoxy fill, wirebonding, and vapor- phase Parylene coating. A second approach is a chip-in-board method using a milled PCB, laser cut stencil, semiconductor processing tape and conductive ink interconnect by syringe printing. Both of these methods achieve approximately 100 microns of total surface topology. These systems have been tested in wind tunnels at the University of Toronto, NASA Ames, and Spirit Aerosystems. In recent work, aerosol jet printing has been used to provide a thin polyimide dielectric coat over the edges of the chip, reducing yield loss for wirebond shorts to the side of the die. Ongoing efforts attempt to further extend the aerosol jet printing to direct-write the interconnects between the MEMS sensor array and the package. The challenge with all three methods is identifying and reducing sources of failure during the packaging process while maintaining a low level of surface topology.

2:40 – 3:05 PM Colonial Room

"Thermogravimetric Study of Dicyandiamide for Application in CVD Growth Process of Single Layer Film of Graphitic Carbon Nitride (g-C_3N_4)", Abdul M. Syed, M.M. Masaki, C.M. Dragun-Bianchi, & J. Therrien **–** University of Massachusetts Lowell, Lowell, MA

A well-characterized and controllable Chemical Vapor Deposition (CVD) based growth process for synthesis of single layer thin films of 2-D carbon-nitride (g-C_3N_4) based semiconductor materials is proposed. Since the discovery of graphene a decade ago there has been an immense interest in the study of 2-D materials beyond graphene in materials science applications, with focus on efficiency, low cost and environmentally friendly methods. Single layer g-C_3N_4 has a wide bandgap (~4.5 eV) and the potential to be enriched with carbon to form an alloy system bounded by g-C_3N_4 and graphene. CVD experiments to date have utilized a thermally decomposed solid source for growth of films, however this approach lacks a significant level of control and the gaseous reactant species are not well characterized. Here we will discuss the use of an easily accessible precursor, dicyandiamide (DiCy), which can be vaporized at low temperatures to achieve a controllable and well-characterized vapor source for the growth of g-C_3N_4. A thorough thermo-gravimetric study of DiCy, performed using a closed system for accessing mass loading and partial pressure of DiCy at various temperatures, along with supporting theoretical studies on single layer, few layer and multi-layer assemblies, and layered Van der Waals solids in general possessing remarkable electronic properties are presented. The initial experiment used sealed containers loaded with a quantity of DiCy. The containers were then heated to specified temperatures and held at these temperatures for about half-an hour to allow the entire system to reach equilibrium. The containers were then cooled and the change in mass of the DiCy was measured. DiCy that passed into vapor phase condensed on the container surface, resulting in a mass loss of the original sample, thus giving variance in mass loading of DiCy w.r.t temperatures ranging between 200°C – 210°C. This information can then be used to control the mass flow rate of DiCy introduced into a CVD reactor by an inert carrier gas, flowing over a solid DiCy sample held at a specific temperature. Such a proposed novel growth mechanism of single layer g-C_3N_4 using CVD system employing DiCy as a precursor, has opened a whole new era in exploiting the inherent optical band gap of g-C_3N_4 for post silicon electronic and optoelectronic devices. The importance of the mass loading curve, at specific temperatures for the precursor DiCy is discussed in detail.

This is a joint effort of an ongoing academic research work at UML via university faculty directed research proposal at the Mark and Elisia Saab Emerging Technologies and Innovation Center (ETIC). The authors thank the University of Massachusetts, Lowell, ECE Dept. and all the UML research centers for their contributions in permitting us to avail their facilities, during course of our research work. Further research project information can be obtained by contacting the following: Professor Joel Therrien, Ph.D., University of Massachusetts Lowell, Lowell, MA

Session H: Poster Papers

Chaired by Dr. Zhiyong Gu (Univ. of MA Lowell) & Dr. Rita Mohanty

In Exhibit Hall – All Day Authors Review: 2:00 – 3:30 PM

"High-resolution Inkjet and 3D Printing", Yang Gou - University of CT, Storrs, CT

Inkjet printing and 3D printing are common additive manufacturing methods for rapid prototyping and flexible electronics fabrication. Inkjet printing is capable of depositing a wide range of materials, such as metallic and carbon particles, polymers, and ceramics, to fabricate flexible electronics and 3-D objects. Inkjet printing is typically characterized by high shear rate (> 104 s-1), short residence time (5 – 250 μs), and high actuation frequencies (~ 20 kHz) that are orders of magnitude larger than what is accessible using conventional rheometers (~15 Hz). In this poster, we will present the development of a stroboscopic imaging platform coupled with a custom-built print chamber. We have combined the imaging platform with digital imaging to investigate the drop formation of fluids containing carbon nanotubes (CNTs) - rolled graphene cylinders with a diameter of ca. 150 nm and an aspect ratio exceeding 40. Of particular interest is how the inclusion of CNTs with different states of aggregation affects the classical Plateau-Rayleigh instability, which further influences the jet breakup and drop size distribution. CNT/polylactic acid composites were fabricated using fused deposition modeling (FDM). We studied the structure-property relationship of the 3D-printed nano-composites using digital image correlation (DIC). The findings of the research may have broader impact in understanding the resolution and printing high-aspect ratio nanoparticles, such as CNTs.

"Optical Approaches for Glucose Biosensing", Jun Chen - University of CT, Storrs, CT

Diabetes mellitus is one of the leading incurable diseases which may lead to severe health complications. The key for diabetes management is regular monitoring and maintenance of blood glucose levels in the body. We present herein three optical glucose biosensors for glucose monitoring-two enzymatic based hydrogel system and one non-enzymatic system. Firstly, a fluorescent enzymatic hydrogel consisting of fluorescein, polyethylene glycol and glucose oxidase (GOx) is employed. GOx catalyzes oxidation of glucose to gluconic acid that interacts with pH-sensitive fluorescein motif in hydrogel and thus significantly quenches its fluorescence, which was optically measured and correlated with glucose concentration. Then, a fluorescence "turn-on" glucose biosensor was investigated by using coumarin as a fluorophore instead of fluorescein. To increase the biocompatibility, both GOx and coumarin were covalent bonded on the matrix of muti-arm polyethylene glycol. The highly porous 3-D structure of the hydrogel allows quick response to glucose within 5 min. However, the behaviors of enzymatic based systems are highly limited by the activity of catalytic enzymes. To elongate the lifespan of the biosensor, non-enzymatic glucose detection system was also developed, in which surface enhanced Raman scattering (SERS) was utilized for glucose sensing using monolayer of 4-mercaptophenylboronic acid (MPBA) self-assembled on Ag nanorods surfaces as the recognition element. Through the specific binding of glucose with the boronic acid motif in MPBA, quantitative detection of glucose in a clinically relevant (0-20 mM) concentration range was successfully demonstrated.

“Screen-printed Electrode (SPE) based Solid-State pH Sensor”, Qiuchen Dong - University of CT, Storrs, CT

Conventional pH measurement in liquid phase has come across painful issues, especially the easily broken glass electrode and limit to large-volume aqueous samples. Therefore, researchers strive to develop robust solid-state pH sensing electrodes for pH measurement in the microliter volume. In this study, screen-printed electrode (SPE) consisting of carbon working electrode (WE), carbon counter electrode (CE) and Ag/AgCl reference electrode (RE) will be used. On the other hand, many metal oxides, such as RuO2, have been introduced into the field for the pH detection. However, iridium oxide (IrOx) is the most promising material involved with electrochemical pH detections. By applying cyclic voltammetry method or drop-casting method, iridium oxide was deposited on the surface of working electrode (WE) of SPE. Hydraulic iridium oxide on SPE had super-Nernst constant under room temperature condition in our case by measuring open circuit potential. In such novel design and configuration, pH can be measured accurately and sensitively, with sensing performance comparable to that of conventional pH meters. This study demonstrates that SPE is an attractive platform of Solid-State pH electrode sensing in the liquid phase since it possesses the advantages of small-size, compatible multiple using condition, low cost, and a long-term stability. It will open a new avenue in pH monitoring.

“Fluorescent Carbon Nano-particles (CNPs) for Explosive Sensing”, Sichen Zhang - University of CT, Storrs, CT

An ultrafast and facile method for the preparation of fluorescent nitrogen-doped carbon nanoparticles (CNPs) has been developed from a single precursor (ammonium citrate dibasic serving as both carbon and nitrogen sources) using cheap home-use microwave oven. The obtained CNPs showed strong blue fluorescence with a quantum yield of ~ 20% and displayed excitation-independent fluorescence behavior. The effects of preparation conditions on fluorescence behavior of CNPs were systematically investigated, while the as-prepared CNPs were thoroughly characterized using various advanced techniques. The mechanism of nanoparticle formation was also discussed and proposed. Furthermore, it was interestingly found that explosive picric acid (PA) could quench the fluorescence signal of CNPs significantly and selectively, while other nitroaromatic explosives have insignificant effect on its fluorescence intensity. The excellent sensing performance to picric acid could be attributed to the synergistic effect of its low molecular orbitals, the presence of fluorescence resonance energy transfer as well as acid-base interactions between picric acid and fluorescent CNPs. These findings here suggest a simple way to prepare highly fluorescent CNPs, which holds great promise in the development of sensitive and selective sensors for PA detection.

“Protein Microspheres with Unique Autofluorescence for Non-invasively Tracking and Modelling of Their In Vivo Biodegradation”, Xiaoyu Ma - University of CT, Storrs, CT

Spray-dried bovine serum albumin (BSA) microspheres were prepared through a facile and low-cost route. Interestingly the as-prepared BSA microspheres possess unique blue-green, green, green-yellow, and red fluorescence when excited by specific wavelengths of laser or LED light. The studies of UV-visible reflectance spectra and fluorescence emission spectra indicated that four classes of fluorescent compounds are presumably formed during the fabrication processes. The formation and the potential contributors for the unique autofluorescence were also discussed and proposed. Good in vitro and in vivo biocompatibility was confirmed by the cytotoxicity test on the A549 cancer cells and tissue histological analysis, respectively. Potential applications of the autofluorescent BSA microspheres were first demonstrated as a novel tracer for convenient tracking/modelling of the biodegradation of injected autofluorescent BSA microspheres in mouse model based on non-invasive, time-dependent fluorescence images of the mice, in which experimental data are in good agreement with the proposed diffusive model. All these studies indicate that the as-developed protein microspheres exhibiting good biocompatibility, biodegradability, and unique autofluorescence, can significantly broaden biomedical applications of protein fluorescent particles.

"Thermogravimetric Study of Dicyandiamide for Application in CVD Growth Process of Single Layer Film of Graphitic Carbon Nitride (g-C_3N_4)", Michael M. Masaki, A.M. Syed, C.M. Dragun-Bianchi, & J. Therrien, University of MA Lowell, Lowell, MA

A well-characterized and controllable Chemical Vapor Deposition (CVD) based growth process for synthesis of single layer thin films of 2-D carbon-nitride (g-C_3N_4) based semiconductor materials is proposed. Since the discovery of graphene a decade ago there has been an immense interest in the study of 2-D materials beyond graphene in materials science applications, with focus on efficiency, low cost and environmentally friendly methods. Single layer g-C_3N_4 has a wide bandgap (~4.5 eV) and the potential to be enriched with carbon to form an alloy system bounded by g-C_3N_4 and graphene. CVD experiments to date have utilized a thermally decomposed solid source for growth of films, however this approach lacks a significant level of control and the gaseous reactant species are not well characterized. Here we will discuss the use of an easily accessible precursor, dicyandiamide (DiCy), which can be vaporized at low temperatures to achieve a controllable and well-characterized vapor source for the growth of g-C_3N_4. A thorough thermo-gravimetric study of DiCy, performed using a closed system for accessing mass loading and partial pressure of DiCy at various temperatures, along with supporting theoretical studies on single layer, few layer and multi-layer assemblies, and layered Van der Waals solids in general possessing remarkable electronic properties are presented. The initial experiment used sealed containers loaded with a quantity of DiCy. The containers were then heated to specified temperatures and held at these temperatures for about half-an hour to allow the entire system to reach equilibrium. The containers were then cooled and the change in mass of the DiCy was measured. DiCy that passed into vapor phase condensed on the container surface, resulting in a mass loss of the original sample, thus giving variance in mass loading of DiCy w.r.t temperatures ranging between 200°C – 210°C. This information can then be used to control the mass flow rate of DiCy introduced into a CVD reactor by an inert carrier gas, flowing over a solid DiCy sample held at a specific temperature. Such a proposed novel growth mechanism of single layer g-C_3N_4 using CVD system employing DiCy as a precursor, has opened a whole new era in exploiting the inherent optical band gap of g-C_3N_4 for post silicon electronic and optoelectronic devices. The importance of the mass loading curve, at specific temperatures for the precursor DiCy is discussed in detail.

This is a joint effort of an ongoing academic research work at UML via university faculty directed research proposal at the Mark and Elisia Saab Emerging Technologies and Innovation Center (ETIC). The authors thank the University of Massachusetts, Lowell, ECE Dept. and all the UML research centers for their contributions in permitting us to avail their facilities, during course of our research work. Further research project information can be obtained by contacting the following: Professor Joel Therrien, Ph.D., ECE Department, University of Massachusetts Lowell, Lowell, MA

"Novel 3D Vertically Aligned Platinum Nanowire Array as Electrocatalysts for Direct Methanol Fuel Cells", Daniel Chuqing Liu - University of MA Lowell, Lowell, MA

In recent years, extensive amounts of research have been done on developing high performance electocatalysts for direct methanol oxidation fuel cells due to its high performance efficiency and environmentally friendly benefits. However, most of the catalysts require alloy of many noble metals such as palladium and gold, involve with complicated preparation methods, and encounter severe catalyst poisoning. In our research, a highly efficient electrochemical catalyst towards methanol oxidation, based on vertical Platinum (Pt) nanowire array, has been developed. The vertical Pt nanowire array was prepared by the electrodeposition method using AAO membrane. Nanowires with different roughness were synthesized by varying the plating current density, and the length of the nanowires were kept uniform by controlling the deposition time. This well aligned array makes it possible for every nanowire to have full contact with the analyte without the nanowires overlapping, and with the help of the rough surfaces, each individual nanowire is able to have a higher surface to volume ratio that further facilitates the reaction. This novel 3D structure showed several advantages such as avoiding the CO poisoning, fully oxidizing the reactants to the desired products, and increasing the electrochemical activity. The results indicate that the 3D electrocatalyst is able to achieve very high performance for generating electron sources for the direct methanol fuel cell; it is also a very promising catalyst for reactions taking place in a different analyte such as ethanol in a basic environment.

"Melting Behavior and Morphology Change of Metallic Nanowires Using Femtosecond Laser Irradiation", Jirui Wang - University of MA Lowell, Lowell, MA

In recent years, flexible electronics have attracted increased interests and attention, such as cell phones, sensors/biosensors, or other electronic devices. However, the assembly and bonding of electronic components or chips onto the flexible substrate are still challenging. One major issue is due to the fact that the melting temperature of the polymer substrates is usually much lower than that of metallic joining or soldering materials. Also, many electronic devices are getting smaller and lighter, and thus, smaller scale solder joints are difficult to form by conventional heating methods. In order to address these issues, the use of femtosecond laser has been proposed to enable micro/nano-scale solder joint formation on flexible polymer substrate. The ease of controlling the shape and location of the heating area leads to minimal component heating and the narrow laser beam enables melting at poorly accessible areas. In our research, the melting of nanowires was studied under femtosecond laser irradiation. Nanowires have been synthesized by electroplating in the nanopores of polycarbonate (PC) template. Different substrate, types of nanowires, heating time and heating circumstances were applied to study their influences to the morphology change of nanowire surface. It was found that the surface of the nanowires has significantly changed but the polyimide substrate remains undamaged after the laser irradiation. We also found that the laser caused different morphology change for different metals under the same irradiation conditions. Moreover, we observed ‘flower’ structure for Sn nanowires by heating them in air, or ‘bead’ structure by heating them in water. The study of the shape and morphology change can lead to a better understanding of laser melting process. The femtosecond laser heating can be used as a new soldering method to overcome some challenging issues, where the conventional soldering methods cannot be applied.

“Counterfeit Component Prevention and Detection”, Scott Mazur - Benchmark, Nashua, NH

“Counterfeit Component Prevention and Detection” will detail the ongoing challenge by the electronics industry to prevent and detect counterfeit components. Since the transition to RoHS, industries which are using leaded components are searching the supply chain to deliver products to customers. Recommendations will be provided for screening of supply chain incoming and receiving processes and subsequent steps required for prevention and detection. Secondary guidelines for detection and identification of counterfeit components including testing verification and analysis with actual case examples of components detected and prevented from being assembled to product.

Exhibits *** Exhibits *** Exhibits

Refreshments, Hors d’oeuvres, Raffles, & Fun in the Exhibit Hall Until 4:30 PM

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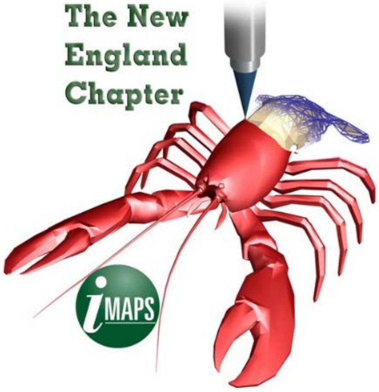

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Industry

- Biomedical Electronics
- Telecom - Microwave
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- Wirebonding and Stud Bumping
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- Ceramic, Polymer and Conductive Materials
- Conformal Electronic Materials
- Wearable / Printed Electronics

Please send 250 word abstract to Jon Medernach – Jon.Medernach@mrsisystems.com
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Denise Radkowski, University of Massachusetts Lowell *(Local Arrangements Chair)*

The International Microelectronics Assembly and Packaging Society (IMAPS) will host an Advanced Technical Workshop on ADDITIVE MANUFACTURING and PRINTED ELECTRONICS on June 28-29, 2016. Printing technology is expected to enable the evolution of electronics from rigid boards to products that are flexible, conformal or wearable. The workshop will bring together experts to report on the progress and the challenges of this emerging field. This technology is expected to impact the options for integration of active and passive components and will exploit additive approaches to advance microelectronic packaging. Conference sessions will cover the development of printable electronic materials (inks), the options for manufacturing/printing and the applications of printed and flexible electronics.

Keynote Speaker: Dr. Benjamin Leever, Government CTO, NextFlex

NextFlex: Building a Manufacturing Ecosystem for Flexible Hybrid Electronics

Sessions are being planned and abstracts are being requested in the following areas:

Materials and Printing Processes	Printed Devices & Packaging	Applications
• Substrates • Conductive inks • Dielectric inks • Functional Ink Development • Printing Technologies • R2R	• Chip Integration • Embedded electronics in 3D • Printed transistors • Additive Packaging • Batteries	• Human and Structural Monitoring • Printed Antennas and RF Devices • Sensors

Those wishing to present at the workshop must submit a 500+ word abstract electronically no later than APRIL 8, 2016, using the on-line submittal form at: www.imaps.org/abstracts.htm. Please contact Brian Schieman by email at bschieman@imaps.org or by phone at 412-368-1621 if you have questions. Full papers are not required. A post-conference download containing the presentation material as supplied by the presenter onsite will be distributed to all attendees. Speakers are required to pay a reduced registration fee.

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Chapter Annual Business Meeting & Election of Officers

Tuesday, June 21, 2016

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SCHEDULE (times approximate)

5:30 PM	Registration, Socializing, Networking & Cash Bar
6:30 PM	Dinner
7:15 PM	Business Meeting & Election of Officers
7:30 PM	Technical Presentation

Nominees for Chapter Office for Fiscal Year 2014-2015

President	Mr. Jon Medernach, MRSI
Vice President	Mr. Dmitry Marchenko, Microsemi
Treasurer	Mr. Minh Tran, Mini-Systems

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