NCCAVS Joint Users Group Meeting

Technology Innovation for Next Generation Materials and Manufacturing

Held in conjunction with the 36th Annual Equipment Exhibition and Student Poster Session

February 19, 2015

Joint Users Group Meeting and Technical Symposium sponsored by:

Indium Corporation

Location/Date/Time
Holiday Inn
1350 N First Street
San Jose, CA
95112
9AM to 5PM
February 19, 2015

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"Technology Innovation for Next Generation Materials and Manufacturing"

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Held in conjunction with the 36th NCCAVS Annual Equipment Exhibition and Student Poster Session. Register in advance for both the Equipment Exhibition and Technical Symposium by clicking here (Free parking validation inside the hotel)

Joint Users Group Meeting and Technical Symposium Committee:

Cesar Clavero (Chair,cesar.clavero@intermolecular.com)
Michael Oye (Past-Chair, moye@ucsc.edu)
David Hansen (CMP)
Gene Davis (CMP)
Lucia Feng (PAG)
Michael Current (JTG)
Sing-Pin Tay (TFUG)

Susan Felch (JTG)

SCHEDULE AND ABSTRACTS

9:00 AM

***Welcome and Introductions*, Cesar Clavero, Intermolecular**

9:05 AM

***Nanotechnology in Next Generation Devices and Manufacturing*, Meyya Meyyappan, NASA Ames Research Center**

This talk will present an overview of some recent exciting nanotechnology research activities at NASA Ames Research Center. First, we have been fabricating nanoscale vacuum tubes over the last two years using entirely and exclusively silicon technology. Vacuum is superior to any semiconductor in terms of electron transport, in addition to being immune to all radiations. We have combined the best of vacuum and silicon technology to fabricate surround gate nanoscale vacuum transistors with a channel dimension of 50 nm in 8 inch wafers. These vacuum transistors, operating at a drive voltage of only 2 V which is remarkable for vacuum devices, have the potential for THz electronics and several other applications. The device physics, fabrication and results will be presented. Next, we have developed an aerosol assisted atmospheric pressure plasma deposition process to efficiently deposit metal, semiconducting, dielectric and biomaterials on flexible substrates and 3D objects. This multijet plasma system can be a dry alternative to inkjet printing in the emerging field of flexible electronics. Finally, results from our recent efforts on paper electronics, especially various types of sensors will be described. The author thanks his NASA Ames colleagues Jin-Woo Han, Ram Prasad Ghandiraman, Beomseok Kim, Jessica Koehne and Michael Oye.

9:55 AM

***Low Emissivity (Low-E) Coating Technologies for Energy Saving Window Applications*, Guowen Ding,**

Intermolecular

Windows are often considered the least energy efficient components in a building. The technologies for improving the energy efficiency of windows have been growing rapidly in the past decade. Such technologies provide solutions in two aspects: (1) control of heat transfer through the window between the indoor and outdoor areas, and (2) control of the solar heat gain performance of the window, (which is different for hot and cold climates, one requires the solar heat gain to be as low as possible for hot climates, and the other requires the opposite). Low-E coating windows provide economic, durable solutions for those requirements. Therefore, the low-E coating market is growing rapidly worldwide. In this presentation, low-E technologies will be reviewed, including monolithic window low-E technology (e.g. in-line low-E technology) and glazing window low-E technology (e.g. off-line low-E technology). The glazing window low-E technology provides better heat radiation control, better solar heat control, and better optical performance, but at a higher price point. Currently, silver based coating technologies are the dominate products for the glazing window low-E products. These technologies consist of single, double, and triple silver products. Finally, general comments on the low-E market will be presented.

10:30 AM

Coffee Break

10:45 AM

Coupling of Surface Light into Lateral Modes of a Waveguide or
***Photonic Resonant Structure, A Finite Difference Finite Time Model Approach to High Accuracy and High Optical Coupling Efficiency*, Ernest Demaray, Antropy Inc.**

It is shown that quantitative results with +/- a few percent accuracy can be obtained by the use of a modified FDFT field solver and appropriate FFT methods for analysis of spectral power over time evolution of as few as 1.6 picoseconds, that light broad band sunlight can be coupled into a lateral high index planar waveguide for transport over multi-meter distance with > 90% efficiency and for selected wavelengths, e.g. 450nm up to 100% efficiency. The modeling development as well as examples of specific computations will be discussed along with new devices for both solar and solid state light collection transport and transformation that might be developed according to this new method.

11:20 AM

***Tunable Properties of Aluminum-Doped Zinc Oxide (Al:ZnO) and Vanadium Dioxide (VO2) for Devices*,Jonathan Skuza, Norfolk State University**

Transition metal and complex oxides have been a burgeoning area of research in recent years due to their unique and tunable properties, which are advantageous for a number of technological devices. Focus will be given to two specific oxides, namely aluminum-doped zinc oxide (Al:ZnO) and vanadium dioxide (VO2). Wide bandgap semiconductors, such as Al:ZnO, have been extremely important for various optoelectronic applications due to the coexistence of high conductivity and high transparency (i.e. transparent conducting oxides). These properties can be tuned through doping (e.g. atomic layer deposition) and have been shown to hold great potential in surpassing the tunability and flexibility of traditional noble metals in nanoplasmonic applications and devices. Materials that exhibit a semiconductor-metal (SMT) or metal-insulator transition (MIT) near room temperature, such as VO2, have become important due to the unique changes in their optical and electronic properties. These properties, of course, can be tailored for use in a multitude of smart devices, which will be discussed.

12:00 PM - 1:00 PM

Free Lunch in the Equipment Exhibition Hall

1:00 PM

***40 Years of Magnetron Sputtering: Still an Exciting Field for Discovery*, Andre Anders, Lawrence Berkeley National Laboratory**

The roots of magnetron sputtering can be traced way back, about 150 years, and the field took off with the invention of the planar magnetron in the early 1970s. Yet, only recently we learned about features of magnetron plasmas which can be observed across various geometries and power levels in both metal and reactive modes. One finds that plasma instabilities are the norm, not the exception. Therefore, our classical picture of operation needs to be modified. This concerns both the way electrons gain energy as well as how current and plasma is transported from the near-target region to the substrate. Electrons gain energy not only via the secondary electron mechanism (the Penning-Thornton paradigm) but make use of the voltage drop in the magnetic presheath. This is very effective because there are many more electrons in the magnetic presheath than there are secondary electrons supplied from the target. This has been discussed by Hou et al. [1] using a global discharge model. This model can be extended to situations where plasma "bunching" leads to moving ionization zones or spokes [2]. Heating of electrons and self-organization of ionization zones are related: ionization is amplified by locally heated electrons, and local heating facilitates the formation of a potential hump. Zone formation is very pronounced for high power impulse magnetron sputtering, however, under certain high power conditions the zones seem to merge and one may speculate that the potential hump is spread out over the entire racetrack region. Clearly, we have not completed the journey of magnetron research.

[1] C. Huo, D. Lundin, M.A. Raadu, A. Anders, J.T. Gudmundsson, N. Brenning, Plasma Sources Sci. Technol. 22 (2013) 045005.

[2] A. Anders, P. Ni, A. Rauch, J. Appl. Phys. 111 (2012) 053304.

1:50 PM

***Using Plasmas to Trap Antihydrogen Atoms*, Joel Fajans, UC Berkeley**

Recently, physicists have managed to create and trap antihydrogen atoms. These atoms consist of a positively charged electron (a positron) orbiting a negatively charge proton (an antiproton), Physicists have long speculating that the properties of these anti-atoms might be different from the properties of normal matter atoms; for instance, though very unlikely, it is possible that these atoms would fall up rather than down. In this talk I will describe how positron and antiproton plasmas are used to create and trap these antimatter atoms.

2:25 PM

***Mechanisms for Ultra-Low Temperature Plasma Activated Direct Wafer Bonding*, Garrett Oakes, EVGroup**

Direct wafer bonding is a straightforward method of directly connecting wafers, with suitable (in terms of micro-roughness, flatness and cleanliness) surfaces, permanently to each other, by bringing them into contact and subsequently annealing them. The conventional process for hydrophilic oxidized Silicon surfaces (native as well as thermal oxide) is well understood, and explained. In contrast, low temperature plasma activated direct wafer bonding is a process that lowers the required annealing temperatures and annealing time necessary for reaching high bond strength and attempts to explain the obtained results using the known model for silicon hydrophilic bonding failed.

In order to clarify the gap closing mechanism, plasma activated wafer surfaces were investigated using surface sensitive techniques such as atomic force microscopy, spectroscopic ellipsometry and Auger electron analysis. Additionally interfaces of bonded wafer pairs with bond strength values of 1500 mJ/m^2 and 2500 mJ/m^2 were investigated using transmission electron microscopy.

Based on this research a theoretical model was developed, which explains the specific results of this process. The model for plasma activated wafer bonding will be presented in detail. This model is based on the model of the classical process, but proposes a different mechanism for gap closure at low annealing temperatures.

3:00 PM

Coffee Break

3:15 PM

***High Efficiency Multi-Junction Solar Cell Based on Diluted Nitrides*, Ferran Suarez, Solar Junction**

Multijunction solar cells, based on III-V semiconductor compounds, have demonstrated high efficiencies for the generation of electricity from solar radiation (1). The efficiency and power improvements make it possible to apply this technology to the space and terrestrial energy markets.

Solar Junction's proprietary dilute nitride material enables lattice matched growth to GaAs and/or Ge substrates. The lattice-matched growth approach increases yield, reliability, and efficiency by avoiding strain and defects. Single substrate growth reduces cost and facilitates the wafer processing.

Dilute nitride material is band-gap tunable from 0.8 eV to 1.4 eV, enabling high material quality for solar cells, and a superior efficiency roadmap.
Multijunction solar cells structures with 3, 4, 5 and 6 junctions will be discussed.
(1) http://www.nrel.gov/ncpv/images/efficiency_chart.jpg

3:50 PM

***New CMP Applications*, Rob Rhoades, Entrepix, Inc.**

CMP was first introduced to electronic device manufacturing to planarize oxide layers in CMOS integrated circuits. Over the past twenty years, usage has expanded to include tungsten vias, shallow trench isolation, polysilicon, copper dual damascene, etc. These processes account for the vast majority of CMP currently being performed around the world. However, a large number of new materials and new devices are now leveraging the unique capabilities of this process to enable new and emerging technology platforms.

New applications of CMP frequently involve significant technical challenges for process and integration teams. For example, MEMS (micro electro-mechanical systems) devices are often much larger in all dimensions than typical CMOS devices with step heights up to tens of microns and feature sizes of several hundred microns being common. These larger features require development of novel and sometimes unique CMP solutions.

Thru silicon vias (TSV's) are being developed for advanced packaging to reduce parasitic losses and shrink form factors. Most TSV process modules rely on CMP at least once, usually twice, during the fabrication sequence. Deposited films for these applications are also thicker than typical CMOS metallization layers and may have unique compositions, thus CMP requires customization and process development with new pads and slurries. In addition, some integrations require via filling with non-standard materials for specialty purposes, such as platinum for high temperature tolerance or polysilicon for voltage sensing with minimal current flow.

4:25 PM

***Advanced Techniques for Simulating Material Properties and Manufacturing Processes*, Mike Hook, Cobham**

In addition to the normal pressures on cost and time-to-market, one ubiquitous theme in product design is the emphasis on achieving ever higher performance. Material selection and process design clearly have significant impact here, as well as on cost and development time. This presentation describes how novel techniques, now available in modern simulation tools, are starting to enable rapid analysis of some of the material properties and process phenomena that can limit product performance, and that previously have been difficult or even intractable to simulate.

The presentation will discuss issues that bear on a wide range of applications, and will include the simulation of magnetization and losses in magnetic materials, analysis of the quench phenomenon in superconducting magnets, and the optimization of manufacturing processes involving plasmas and charged particle beams. The discussion will illustrate the capabilities of modern software using examples simulated in the Opera multiphysics simulation software tool for designers of electromagnetic equipment.

5:00 PM

Adjourn Joint Users Group Meeting and Technical Symposium.
Note that the Equipment Exhibition is open until 7PM!

All presentations will be requested to be posted on the Joint Users Group Proceedings webpage.

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