

**CHALLENGES AND NEW APPLICATIONS  
IN VACUUM MICROELECTRONICS:  
A LOOK AT IVMC-2001**

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The Fourteenth International Vacuum Microelectronics Conference (IVMC-2001) was held on the campus of the University of California, Davis August 12-16, 2001. The Authors served as Chair and Co-Organizers of this Meeting. The Conference was attended by almost 200 participants. The attendees, geographically, were 39% US, 21% European, and 41% Asian. The affiliation of the attendees was 50% academic, 40% industrial, and 10% government research. The Conference had four days of oral technical sessions and a continuous poster session. There were 149 accepted contributed presentations and five invited speakers.

IVMC-2001 demonstrated how the vacuum microelectronics field has branched from its initial interest areas, which were predominantly microwave amplifier applications, through a decade of exploration of the field-emission flat-panel display, into new interests which are emerging. The Conference opened with a session on novel applications of field-emission cathodes. New applications include space electronics ("vacuum ICs"), power switches, a free electron laser, nano-scale x-ray sources, high-resolution retarding field analyzers, and spacecraft propulsion systems. There also were presentations of application to high-throughput lithography systems, tera-bit mass storage devices, vacuum fluorescent lights and mercury-free, energy-efficient lamps. There also was a demonstration of the continuing progress in microwave amplifiers and FE displays.

Considerable research has been made in the area of carbon-based field emission surfaces. These were strongly represented at IVMC-2001. This includes carbon nanotubes (CNT), diamond and diamond-containing films, and graphitic and vitreous carbon as well. Four half-day sessions of IVMC-2001 were devoted to these topics. Progress is evident in CNT deposition methods and several programs are targeting commercial products which use these, especially for displays. Reticulated vitreous carbon was demonstrated as an efficient lamp material. Nano-crystalline diamond was demonstrated as a potential low-noise emission surface. New composite carbon-graphite materials were demonstrated as well, showing great promise, not only for ease of deposition, but for low-field, high current, stable, emission as well. Many of the presentations addressed the theory of emission from these materials and call into question some of the accepted models which have been used.

The interest in metal, additive "Spindt" cathodes continues, especially when coated with dissimilar materials such as HfC and ZrC. Several presentations continued to examine the use of silicon and other semiconductors in cathodes. One presentation showed emission from an array of individually-addressable, single-tip Si cathodes with integral

focussing. Several presentations showed results from devices with GaN and other wide-gap cathodes, including some with BN coatings. Many of the results from coated cathodes were exciting for their stable, reproducible, low-noise, and low-field operation. Finally, there continues to be guarded optimism about the promise of field-emission flat-panel displays. Both US and Asian industrial groups presented new results and several very attractive prototypes were demonstrated. It appears that FED commercialization is underway in Asia.

The annual Shoulders-Gray-Spindt Award, for the best student presentation, went to James Carey of Harvard University for his work (with Prof. Eric Mazur) on modification of surface morphology with laser pulses for increased stable emission. The competition for the award was very tough, however, as outstanding student presentations came from several multiple institutions, including Ajou University in Korea, Vanderbilt, MIT, the General Physics Institute in Moscow, Kyoto University, Cambridge, University of Wuppertal, Zhangshan University, UC Davis, Seoul National University and others.

The presentations of IVMC-2001 are documented in the proceedings volume [1] and it is anticipated that approximately 40% of those presentations will have peer-reviewed archival inclusions in a Spring, 2002 special issue of the *Journal of Vacuum Science Technology-B*. The American Vacuum Society anticipates *JVST-B* being the annual forum for IVMC papers, and the IEEE-EDS expects to continue as Sponsor for IVMC Meetings in the USA.

The 15<sup>th</sup> International Vacuum Microelectronics Conference, which will coincide with the 48<sup>th</sup> International Field Emission Symposium, will be held July 7-11, 2002 in Lyon, France. Those interested should refer to <http://IVMC2002.univ-lyon1.fr>. IVMC-2003 is planned for Kyoto, Japan. Future IVMC meetings are envisioned to rotate between the USA, Europe, and Asia.

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[1] *Proceedings of the 14<sup>th</sup> International Vacuum Microelectronics Conference*, August 12-16, 2001, University of California, Davis. ISBN 0-7803-7197-6, IEEE, Piscataway, NJ. Available by contacting the Authors or through IEEE.