

## ***Standards Ecosystem for Nano- and Macro-Manufacturing: Key Components in the Bridge to Commercialization***

Standards and their associated measurements are key to successful innovation, commercialization and job creation. They are the invisible catalyst for efficient economies. The international ecosystem for standards and metrology is vast and diverse. Among the many standards developing organizations, this presentation highlights the structure, projects, and inter-relationships of the nanotechnologies standards committees for the Institute of Electrical and Electronics Engineers, the International Electrotechnical Commission, and the International Standards Organization. Essential ingredients for quality standards include sound science and engineering principles, reproducible measurements, manageable number of key processing characteristics and performance metrics, and agreement among all stakeholders. Grand challenges are sustaining effective communications, cooperation, and collaboration among stakeholders and understanding interfaces well enough to control and reproduce performance figures of merit in high volume manufacturing.

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Herbert Bennett has many years of experience in measurements and international standards for electronic, magnetic, and optical materials and devices. He has held research and management positions at NIST and Departments of Defense and Commerce, and was the Director of the Materials Research Division at the National Science Foundation from 1978 to 1980. His research is archived in over 200 publications on diverse topics such as magnetic phase transitions, color centers, damage in laser materials, semiconductor physics, optoelectronics, video technologies, quantitative medical imaging, and nanoscale interfaces. He has contributed to many international roadmaps for semiconductors and RF and analog/mixed-signal (AMS) technologies and to developing international standards. He co-founded in 2002 the RF and AMS Technical Working Group of the ITRS and recently the ITRS MEMS Technical Working Group. Some of his IEEE activities include: elected member of the IEEE-Standard Association Board of Governors (2012-2013), elected member of the IEEE Electron Devices Society Administrative Committee (1995-2000), and guest editor of special IEEE Transactions issues on compound semiconductor manufacturing (2003), on simulation and modeling of nanoelectronic devices (2007), and on characterization of nano CMOS variability by simulation and measurements (2011). He was the U.S. representative to the International Electrotechnical Commission (IEC) Advisory Board on Nanotechnologies (ABN20) from 2003-2005, and co-founded the IEC Technical Committee TC 113 on standards for nano-electrotechnologies (IEC TC 113). He currently is one of 5 members of the IEC TC 113 Chairman's Advisory Group (CAG). He is a charter member of the US Senior Executive Service, recipient of the US Commerce Department's Bronze Medal for superior Federal service and of Maryland's Outstanding Young Scientist Award. An IEEE Life Fellow, a Fellow of the American Physical Society, and a Fellow of the Materials Research Society, he received A.B. and Ph.D. degrees from Harvard University in theoretical solid-state physics and the M.S. degree from University of Maryland in physics and mathematics.