Accelerating Research in Applied Nanotechnology

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At the turn of the 21st Century, President Clinton’s speech at Caltech helped to launch the U.S. National Nanotechnology Initiative. After ramping by a factor of three over 2001–2008, federal funding for nanoscale science and technology research has averaged over $1.5B/year for the past decade. Comparable investments have been made by state and private research universities in nano-fabrication and characterization facilities and tools over this period. Although the understanding and manipulation of matter on the nanoscale has grown tremendously, the commercial application and impact of these discoveries has been slower than anticipated when the NNI was launched.

My talk will consider the role that shared academic nano facilities, such as nano@Stanford and MIT.nano, can play in nucleating the tools and processes, as well as the community of internal and external researchers, that can accelerate the commercialization of nanotechnology. The challenge of operating these facilities has grown over the past decade, due to the wide range of materials and fabrication processes that are required for electronic, photonic, and sensory systems. Moreover, the growth of nanotechnologies for energy conversion and storage, as well as for biomedical systems, has created the need for new tools and processes that don’t fit inside the conventional lithographic paradigm. The opportunity and challenge for universities is to create broader, more capable shared facilities that enable users to make system prototypes, rather than devices or components.

I will discuss Stanford’s recent experiments in taking our shared fabrication facilities in new directions through the “Experimental Fab” and its impact on our evolving user community. My own group’s experience in making a low work function electrode by electrostatically gating graphene has shown the need for new tools to enable transfer processes. In addition, my group has developed a broad-spectrum electronic biomolecular sensor that requires a nanoscale electrode with an extremely low parasitic capacitance. Unconventional tools were critical role in accelerating the understanding of the design of the electrochemical interface and demonstrating the basic functionality of the sensor. It has been used to detect a variety of analytes in complex media, such as serum, from tunneling current signatures. My talk will conclude with my thoughts on how we can speed the dawning of the Nano Age.

Roger T. Howe is the William E. Ayer Professor of Engineering at Stanford University. He received a B.S. in physics from Harvey Mudd College in 1979 and an M.S. and Ph.D. in electrical engineering from the University of California, Berkeley in 1981 and 1984. After faculty positions at CMU and MIT from 1984 – 1987, he returned to Berkeley where he was a Professor until 2005. His research group focuses on nanoscale system design and fabrication for a variety of applications. He was the Faculty Director of the Stanford Nanofabrication Facility from 2009 – 2017 was Director of the NSF’s National Nanotechnology Infrastructure Network (NNIN) from 2011 – 2015. In 2016, he co-founded ProbiusDx, Inc. to commercialize research in his group on a broad-spectrum biomolecular sensor.