NSF WORKSHOP ON QUANTUM SYSTEMS AND DEVICES MANUFACTURING

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Abstract: Quantum computing, communications, and sensing systems promise significant advances in information processing and security, computing efficiency, and sensing acuity. While current quantum systems utilize a diverse set of physical device and circuit technologies, they all initialize, read-out, and operate on atomic, electronic, or photonic quantum states. For information to be encoded and remain in usable device quantum states, as qubits, stringent requirements are placed on device manufacturing; in particular, precision, reproducibility, and scalability. In addition, qubit states must be protected from unintended environment stimuli, such as temperature and radiation, which can cause system errors due to uncontrolled state changes.
The diverse set of quantum system platforms range from those just entering the commercial market, such as superconducting circuits and ion traps, to exciting research prospects such as single-electron transistors, point-defect based sensors, and two-dimensional topological materials. These approaches present unique and significant challenges in manufacturing. For a strong infrastructure and scientific leadership to develop, these manufacturing challenges need to be understood, new approaches developed, and the robustness of the processes understood.
Based on these considerations, a four-day virtual workshop was held in May 2021 to assess the status and identify challenges in quantum device/circuit manufacturing and quantum system integration. The workshop facilitated a research agenda for the community and NSF in the new area of quantum device manufacturing. *The goals of the workshop were to: 1) identify and recommend manufacturing research actions that will advance the success and utilization of current and future qubit platform and systems; 2) enlarge and engage a larger research community in computer science, materials, engineering, physics and beyond; 3) find synergies and seed cross-disciplinary research connections*. The recommendations arising from these goals support the advancement of quantum system development and provide NSF with information needed to help guide quantum system manufacturing research and tool development. The primary goal of the workshop was to identify and recommend actions addressing manufacturing challenges in present and future platforms enabling quantum computing, communications, and sensing. This presentation will summarize those findings.

Bio note: April Brown's research focus is on the synthesis and design of electronic materials for devices and the properties of semiconductor- and metal-based nanostructures.

Professor Brown received her B.S.E.E. in 1981 from North Carolina State University, and her M.S.E.E. and Ph.D. from Cornell University in 1984 and 1985. She started her career as an Assistant Professor at the University of Michigan in 1985 and joined the Hughes Research Laboratories in 1986 as a Member of the Technical Staff. When she left HRL in 1994 she held the position of Sr. Scientist after holding the position of Section Head from 1989-1991. In addition, she was a Program Manager in the Physics Division at ARO in 1988-1989. She joined Georgia Tech as an Associate Professor in 1994 and held the position of the Pettit Professor in Microelectronics when she left in 2002 to join Duke University. She also served as Associate Dean in the College of Engineering at Georgia Tech from 1999-2001, and Executive Assistant to the President from 2001-2002. She is currently a Professor of Electrical and Computer Engineering at Duke University. She served as Department Chair in ECE at Duke from 2002-2006 and Sr. Associate Dean for Research from 2007-2011. She was also Senior Research Scientist in Electronics at the Army Research Office from 2015-2017. She is a Fellow of the American Physical Society and the Institute of Electrical and Electronics Engineers.