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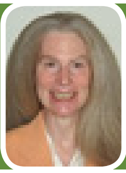

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Nanowires and Nano-enhanced Properties: What Proofs are Definitive?

The implications of nanotechnology are wide-ranging and include medicine, military applications, computing, and astronomy. There is therefore growing recognition of the importance of nurturing a community of scientists and engineers with the necessary skill set(s) needed to establish definitive proof that nanostructures and/or nano- enhanced properties are present. In the present discussion, the combinations required to establish two new discoveries in semiconducting and metallic nanowires will be presented. The first investigation details our contributions to recognition that gallium nitride nanowires, which are candidates for nanoelectronics and nanowire lasers, have interior structures that will affect their performance. An initial key observation of new "biphasic" wurtzite/zinc-blende crystalline homostructure with a sharp phase transition of 1-3 atomic layers emerged unexpectedly during a high resolution transmission electron microscopy (HRTEM) investigation of nanowires grown at 850oC. Initial "proofs" came from electron diffraction and cathodoluminescence studies that yielded unambiguous evidence for two different crystal structures and energy bandgaps, but additional HRTEM of focused ion beam cross sections was required to replace "biphasic" with the correct "nanowires within a nanowire" internal structure. Furthermore, the internal structure proved to be synthesis temperature-dependent, with an abrupt change to pure wurtzite and unanticipated internal nanopipes at 1000oC. The nanopipes identified the growth mechanism, as well as provided information for device designs. The second is an ongoing investigation of highly crystalline nickel, cobalt and alloy nanowires, which have multiple magnetic and optical sensing, and also biomedical, applications. Once again, there was an initial key observation of an unexpected result: areas of well-formed ~40-80 nm nanowires discovered during an atomic force microscopy investigation of a nanocrystalline film surface. Extensive use of recently available high resolution scanning electron microscopy with selected area energy dispersive X-ray spectroscopy demonstrated that the new regime of high-speed turbulent flow electrodeposition coupled with a thin hydrocarbon layer on the surface produced carbon nanowire-catalyst particles in metallic ion "gas" environment, while HRTEM confirmed crystallinity that exceeds current state of the art in anodized template synthesis.

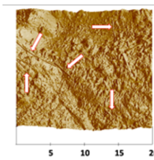

Figure 1. Initial key observation of unexpected result: areas of well-formed ~40-80 nm diameter nanowires (arrows) discovered during an atomic force microscopy investigation of a nanocrystalline film surface. Subsequent analysis using selected area energy dispersive X-ray spectroscopy and HRTEM provided definitive proof that these are highly crystalline nickel, cobalt and alloy nanowires.

Biography

Virginia M Ayres earned the Ph.D. and M.S. in Physics from Purdue University, and B.A.'s in Physics and Biophysics from Johns Hopkins University. She is currently an Associate Professor in the Department of Electrical & Computer Engineering at Michigan State University, where she heads the Electronic and Biological Nanostructures Laboratory. Professor Ayres is the recipient of numerous NSF, NASA and international awards that support ongoing research in nanoelectronics and nanobiophysics. She is honored to be the recipient of awards as a Chair of International Cooperation at Tokyo Institute of Technology and as a Distinguished Women Scholar and a Department of Physics Outstanding Alumna from Purdue University.

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