Nanowires—Synthesis, Properties, Assembly and Applications

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Nanowires—Synthesis, Properties, Assembly and Applications

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PREFACE

One-dimensional nanowires support the transport of charge carriers, photons and ions along their length while maintaining nanoscale effects across their diameter. The unique nanowires from versatile materials have shown great promise in nanoscale electronics, photonics, thermoelectrics, biotechnology, and energy conversion. Symposium LL, "Nanowires—Synthesis, Properties, Assembly and Applications," held December 1–5 at the 2008 MRS Fall Meeting, in Boston, Massachusetts, has provided the opportunity for discussing the critical issues related to nanowires and recent progresses in synthesis, structure, properties and devices. Specific topics of the symposium covered:

(1) Synthesis with control over composition, size, shape, position, geometry, doping, alloying and heterostructures. Materials include Group IV, III-V, II-VI, metal and metal oxide and chalcogenide materials.
(2) Properties: mechanical, electronic, optical, thermal, magnetic, ionic, phase transformational, chemical properties, etc.
(3) Assembly and integration: methods for organizing nanowires, multiple length scale pattern formation, heterogeneous integration, assembly architecture, etc.
(4) Applications: functional devices and systems for electronics, photonics, sensors, renewable energy.

The symposium consisted of 98 oral presentations, of which 14 were invited, and 142 poster presentations. The presentations were grouped into topical sessions, which covered growth mechanisms, doping, memory and logic applications, emerging applications, optical and magnetic properties, electromechanical properties, electrical and thermal transport, sensing, heterostructure synthesis, photodetection, and the synthesis and properties of metallic nanowires.

By all accounts, our symposium has been an astounding success. We received a total of 272 abstracts, second only to Symposium JJ, which also included the subject of nanowires. Due to the large number of submissions, Symposium LL included oral sessions throughout the entire 5 days of the conference, as well as 3 poster nights. Session attendance was consistently high, including several presentations with standing room only.

Many outstanding talks and posters were presented at the symposium. The presentations that particularly stand out include the invited lecture by Prof. Charles Lieber, in which he traced the developments in nanowires, highlighting the various fundamental scientific and technologically significant discoveries, such as chem/bio sensing, nanoscale light sources, quantum electronics, etc. that have been enabled by semiconductor nanowires. Another paper worth mentioning was by Naoki Fukata et al., from National Institute for Materials Sciences, Tsukuba, Japan, titled “Phosphorus Donors and Boron Acceptors in Silicon Nanowires Synthesized by Laser Ablation.” Fukata used a combination of Raman scattering and ESR measurements to show how

P and B dopant incorporate and preferentially segregate in Si nanowires. Dopant control is key to making functional nanowire devices, and the poster by Fukata et al. received the MRS poster award. Another outstanding paper was presented by Irene Goldthorpe, from Stanford, titled "Synthesis and Strain Relaxation Mechanisms of Ge-core/Si-shell Nanowires." The paper, which won the graduate student award silver medal, discussed in detail the strain relief mechanisms in Ge/Si core shell nanowires. Another noteworthy paper which also won the silver medal was presented by Y. Jung, from Materials Science and Engineering, University of Pennsylvania, titled "Phase-Change Nanowires: Size-dependent Electronic Memory Switching and Core/shell Heterostructured Multi-state Memory." Jung et al. reported on two classes of phase change nanowires based on the GST materials system and their memory switching characteristics, and related that these nanowires satisfy many of the technological requirements for successful device implementation.

Semiconductor nanowires are rich in fundamental issues and promise revolutionary new device concepts. Devices fabricated from these nanoscale structures may offer significantly improved photonic and electronic performance. Given the interest, fascination, and rapid development in the field of nanowires, this topic should continue to figure prominently among MRS symposia. Many fundamental issues concerning nanowire growth mechanisms, dopant incorporation, heterostructures, role of surface states, contact formation, and integration into functional devices remain unclear and will undoubtedly generate interest in the scientific community. Equally important are the new opportunities associated with advances in nanowire science and technology, such as applications of these materials in energy harvesting and conversion, chemical and biological sensing, and novel memory and logic devices.

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