Introduction

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Research on nanowires addresses both fundamental investigations of crystal growth and the scaling of materials properties to molecular dimensions and use-inspired studies of single nanowire devices and their assembly into functional architectures. Because it encompasses both basic scientific questions and exciting technological applications, nanowire research has attracted the attention of scientists and engineers worldwide. The number of research papers published per year related to nanowires has grown exponentially in recent years.[1] The current era of intense activity has its origins in the 1990s, when initial research results on semiconductor wires of nanoscopic dimensions were first reported by Hiruma et al.,[2] Westwater et al.,[3] and Morales and Lieber.[4] However, their very influential work on true nanowires was itself a continuation, at smaller dimensional scales, of many years of research on larger diameter, filamentary crystals referred to as "whiskers." The discovery, by Wagner and Ellis,[5] of the vapor–liquid–solid (VLS) method for locally catalyzed crystal growth of Si whiskers using Au as a solvent was the seminal event in the early history of the field, and it has enabled and informed much subsequent research. Today, investigations of semiconducting, metallic, and insulating nanowires synthesized by VLS, by other locally catalyzed mechanisms, and by processes that do not require the presence of a catalyst particle are being pursued, as are studies of "top-down" patterned and etched wire-like nanostructures for a host of applications.

In addition to its scientific and technological potential, a major attraction of research in this field is its interdisciplinary nature, which seems to offer something to almost all of the sciences and engineering disciplines and to touch all of the vertices of the "materials research tetrahedron"—structure, properties, processing, and performance. As such, publishing a special issue on nanowires in *Journal of Materials Research*, a journal of MRS, that most interdisciplinary materials society, is very appropriate. The goal of this *JMR* special issue is to provide a current snapshot of nanowire research in the sixth decade since the publication of Wagner and Ellis' paper on VLS and to review developments since then that may pave the way for future discoveries. Several of the papers in this issue address questions about the nature of VLS growth and how to model it, an example being the molecular dynamics calculations reported by Ryu and Cai[6] for simulating Si nanowire growth from a Au–Si liquid droplet. Others focus on issues of basic importance for applications, including doping of semiconductor nanowires (Wallentin and Borgström[7]) and the effects of surfaces on their properties (Geelhaar et al.[8]). Alternative wire growth methods and approaches for manipulation and assembly of nanowires are also featured. Finally, several papers in the issue report on the performance of nanowires in molecular sensing and in electrochemical energy storage, promising contemporary applications for "bottom-up" synthesized nanowires.

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REFERENCES

1. V. Schmidt, J.V. Wittemann, S. Senz, and U. Gösele: Silicon nanowires: A review on aspects of their growth and their electrical properties. *Adv. Mater*. **21**, 2681 (2009).
2. K. Hiruma, M. Yazawa, T. Katsuyama, K. Ogawa, K. Haraguchi, M. Koguchi, and H. Kakibayashi: Growth and optical properties of nanometer-scale GaAs and InAs whiskers. *J. Appl. Phys*. **77**, 447 (1995).

3. J. Westwater, D.P. Gosain, S. Tomiya, S. Usui, and H. Ruda: Growth of silicon nanowires via gold/silane vapor–liquid–solid reaction. *J. Vac. Sci. Technol. B* **15**, 554 (1997).
4. A.M. Morales and C.M. Lieber: A laser ablation method for the synthesis of crystalline semiconductor nanowires. *Science* **279**, 208 (1998).
5. R.S. Wagner and W.C. Ellis: Vapor-liquid-solid mechanism of single crystal growth. *Appl. Phys. Lett*. **4**, 89 (1964).
6. S. Ryu and W. Cai: Molecular dynamics simulations of gold-catalyzed growth of silicon bulk crystals and nanowires. *J. Mater. Res*. **26**, 17 (2011).
7. J. Wallentin and M.T. Borgström: Doping of semiconductor nanowires. *J. Mater. Res*. **26**, 17 (2011).
8. R. Calarco, T. Stoica, O. Brandt, and L. Geelhaar: Surface-induced effects in GaN nanowires. *J. Mater. Res*. **26**, 17 (2011).