Nanomanufacturing Outside the Lab: A Case Study in Academic-Industry Partnerships

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Abstract

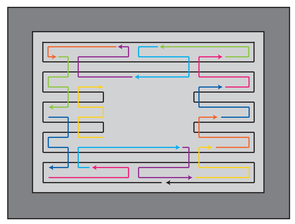
One of the National Nanotechnology Initiative's Signature Initiatives is Sustainable Manufacturing. With over $20 billion invested in nanotechnology research and development by the US government since 2000 [1], there is now an emphasis on transitioning from primarily fundamental research to work aimed at overcoming the barriers preventing these technologies from being successfully produced and integrated into devices manufactured at an industrial scale.

To date, much focus has been placed on the technical barriers to commercialization. However, other barriers outside of the lab must also be addressed in order to achieve broad commercialization of nanotechnology. The Public Policy Research Center (PPRC) at Boise State Unviersity is conducting a case study of a partnership between Boise State University, Micron Technologies, and the Wyss Institute at Harvard University, funded by the National Science Foundation's Scalable Nanomanufacturing (SNM) program. These three partners are examining the use of DNA nanostructures in semiconductor memory manufacturing. The PPRC aims to investigate policy and cultural barriers to commercialization in the context of this project and to gain a greater understanding of such issues relative to nanotechnology and other emerging technologies developed through academic-industry partnerships.

This case study uses interviews with principal investigators, university administrators, and other stakeholders in the project (at Boise State, Micron, and Harvard) to collect their perspectives on the challenges and opportunities of university-industry partnerships and of scaling nanotechnology in manufacturing.

Materials Science Goals

Figure 1:
Example schematic of a DNA origami structure inside a patterned hole on a silicon wafer



- Use programmably self-assembled DNA nanostructures in manufacturing silicon-based memory to create smaller features
  - Deposit and position DNA on silicon wafer surfaces
- Use DNA labeled with fluorescent dyes to detect defects in structures

Methodology

Qualitative interviews of researchers and administrators on the SNM project

Public Policy Goals

- Identify barriers "outside of the lab" that could prevent large-scale commercialization of nanotechnology and other emerging technologies that are developed through university-industry parterships, as well as potential solutions to overcome these barriers
  - Regulation
  - Public acceptance
  - Difficulties at the interface of academia and industry
- Draw conclusions and lessons from this case study to apply to future projects

Academic-Industry Partnerships: Pros & Cons for University Researchers

Advantages:
- Access to additional resources and materials through the industry partner
- Closer relationship with a (local) company
- Insight into the priorities of industry and what is or isn't realistic to manufacture
- Opportunities for students working on the project

Disadvantages:
- Pressure from industry partners regarding project timelines
- Have to work out intellectual property agreement
- May not have full access to proprietary processes

Academic-Industry Partnerships: Pros & Cons for Industry Partners

Advantages:
- Can have a university lab do exploratory research and development that may be hard to justify for the company if a direct path to a product is not clear
- Gain insight into what new technologies are under development

Disadvantages:
- University professors and students have many competing demands on their time, so their progress is often slow, compared with a typical worker in industry

University Researcher Views on Public Acceptance of this Technnology

- In general, all three researchers agreed that the public is not very well informed or aware of this particular technology
- Reactions from the public that researchers had experienced varied depending on how the issue was framed
  - Some people were concerned by the use of DNA or curious about the source
  - Also depended on education level of the audience
- Researchers' concerns as scientists about fearmongering were sometimes at odds with their concerns as citizens about the rapid development of technology (often faster than the public can stay informed)

What University Researchers Feel They Got Out of the Partnership

- Access to materials (different types of doped silicon surfaces to test) and characterization equipment
- Experience working with Micron and learning what their priorities are
- Opportunities to collaborate with Micron on other projects (including future joint grant applications)
- Connections for students who have gotten internships or full-time jobs at Micron as a result of the project and related projects
- They feel that this project may have strenthened Micron's investment in Boise State and contributed to a recent $25 million gift from the Micron Foundation to fund a new Center for Materials Research

Acknowledgements

1. New Initiatives to Accelerate the Commercialization of Nanotechnology | whitehouse.gov. Available at: https://www.whitehouse.gov/blog/2015/05/20/new-initiatives-accelerate-commercialization-nanotechnology. (Accessed: 22nd April 2016)

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