A Brief Overview of Nanotechnology Adoption by Industry

Industries Using Nanotechnology

Nanotechnology has been a major topic in research and development for quite some time now. Research into nanoscience can lead to many industrial advances, if only their potential may be effectively harnessed to solve a need.

Currently, there are many uses for nanotechnology in specialized industries. The most widespread ones I am aware of are in semiconductor devices and advanced materials. Another large industry is equipment for both nanoscale metrology and processing. The majority of companies with some form of nanotechnology work fall into one of these seven categories:

• Semiconductors

• Materials, chemicals, and nanomaterials

• MEMS including Bio-MEMS and microsensors

• Electronics and electronic components

• Research and development or laboratory analysis services

• Optics and photonics

• Tools and capital equipment

I have written brief summaries of the industries use nanotechnology the most and created a map with over 2000 companies in the United States with some work in nanotechnology here: http://scme-nm.org/index.php?option=com_content&view=article&id=403&Itemid=311

Most companies I know of using nanotechnology produce nanotechnology enabled products then sell them. A large number of other companies are end users of nanotechnology products, buying then integrating at least one nanotechnology enabled component into their final product. Many others create the equipment needed to produce, integrate, or characterize nanotechnology products.

How New Nanotechnologies are Adopted

From my experience, the knowledge needed to create nanotechnology products comes from either academic and government research institutions or corporate research and development departments. An entrepreneur or cooperate product development group then takes a risk and attempts to create a viable product aimed at a specific need or market. Tailoring a nanotechnology product to meet that need (and requirements of the corresponding market) then selling it are the most challenging parts to bringing nanotechnology into industry.

There are also several major challenges to bringing nanotechnology breakthroughs out of research and development. These include but are not limited to:

• Technology transfer and licensing policies that discourage licensing or entrepreneurship

• Inadequate technology readiness

• Inability to reliably manufacture the technology

• Unclear use or market demand for a specific technology

The Nanotechnology Workforce

Since nanotechnology has many specialized applications across many industries, most uses require a specialized set of skills to master. While exceptions exist, many companies do not have dedicated nanotechnology divisions but instead small, multidisciplinary teams focused on specific projects. Engineers and scientists hired typically have degrees and experience specific to the specialty of their employer. From my experience and discussions with industry professionals, common skills of technicians are metrology and production or the assembly and maintenance of new equipment. Engineers often are concerned with the design, integration, testing, and technical review of nanotechnology products.

Recently, there has been a push to create nanotechnology degree programs at all postsecondary education levels: community college associates degrees to train technicians plus university Bachelor's and graduate degrees to train engineers and scientists. Training a nanotechnology workforce, however, comes with unique challenges. One of the most challenging is to cover enough material to properly prepare students to obtain work in as many specialized, and often dissimilar, jobs relating to nanotechnology. This leaves educators with a dilemma: try to teach everything possibly relevant to nanoscience or focus deeply in a handful of skills specific to an industry or type of job. If done right, the first option can give students a flexible set of skills. The second can lead to better job placement. Other challenges are providing students with enough lab and project experience, which are essential to land good technical jobs.

I have blogged about topics relating to my experience in nanotechnology degree programs here: https://thenanostudent.wordpress.com/.