

## Nanotechnology: Editorial Issues Posed by a New (?) Field

Rita M Washko

As gatekeepers of scientific progress, editors must keep abreast of major trends and future promises and must provide context for emerging science. A contemporary example is nanotechnology.

*Nanotechnology* is a term that captivates the imaginations of starry-eyed science-fiction buffs but leaves some formally trained scientists questioning whether it is just a new name for old science or a new frontier in science. How can editors fulfill their role as gatekeeper and separate fact from fiction? To answer that question, opinions were sought from those who are shaping the nanotechnology movement and those whose job it is to scrutinize purported developments in this burgeoning technology. Below are comments from the following:

- Mihail C Roco, head of the National Nanotechnology Initiative (NNI), a federal research and development enterprise.
- Elizabeth L (Betsy) Fleischer, editor of *MRS Bulletin*, the publication of the Materials Research Society.
- James Von Her, founder of Zyvex Corporation, the first nanotechnology development company.
- Martin Blume, editor-in-chief of the American Physical Society and senior physicist at Brookhaven National Laboratory.
- Tachung C Yih, chair of the University of Texas at San Antonio Department of Mechanical Engineering and executive editor of *Nanomedicine: Nanotechnology, Biology, and Medicine*.
- Lionel Vaysieres, senior research scientist at Lawrence Berkeley National

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### Background

*Nanotechnology* refers to dimensions. Any material can be reduced to its smallest component—atoms and molecules—but the true definition of *nanotechnology*, according to Roco, requires that three criteria be met. First, the substance must measure 1 to 100 nanometers (nm). (A nanometer is one-billionth of a meter; the width of a human hair is about 80,000 nm.) Second, it must have been designed through a process that enables its control and manipulation. Third, it must be possible for the substance to be combined to form larger structures.

The beginning of the nanotechnology movement dates back to 1959 when American physicist and Nobel laureate Richard Feynman gave a speech, “There’s Plenty of Room at the Bottom”.<sup>1</sup> Feynman challenged the scientific community to explore the “staggeringly small world” beyond that of miniaturization. But it was not until 1981 that International Business Machines researchers developed the scanning tunneling microscope, which allowed scientists to see the atoms and molecules at this infinitesimal dimension.<sup>2</sup> Several years later, the atomic-force microscope was developed; it allow visualization and manipulation of substances on a nanometer scale.<sup>3</sup> By the year 2000, President Bill Clinton had become interested in the nanotechnology movement and approved the NNI, touted as the largest federally funded scientific endeavor since the exploration of space.<sup>4</sup> The initiative was made law by President George W Bush when he signed the 21st Century Nanotechnology Development Act, which allocated \$3.7 billion to federal agencies for 2005–2008.<sup>5</sup>

### What Is New, Really?

Editors who review nanotechnology-tagged

information must first ask, What is new? A nanotechnology label could represent new science, a new scale for science, or simply a new terminology applied to established science, Fleischer said. For “new science”, the usual process of evaluation must proceed. “The role that journals play to help disseminate such studies is important”, she said. “In the ‘new scale for science’ category, this is just an extension of trends in some areas”, Fleischer said. She gave the example of electronics, stating that the science moved to the micro scale (microelectronics) and then into the nanoscale. “This moves a whole body of science into the ‘nanoregime’.” There is new science here as well, but editors need to look for what is recast on a new scale rather than truly new science.

“The third category of ‘new terminology’ is evident to me because every topic now has nano added to it”, Fleischer said. “Fields are moving into this scale, and fields are renaming themselves.” Editors need to “make sure nano is applied when it is appropriate, not just added to get noticed”.

Roco said that when it comes down to it, “everything around us is nanostructure”. The ability to manipulate and create nanostructure is what is new.

### Issues

From an editorial standpoint, several other issues are important to consider, such as how to deal with the following:

- Consistent nomenclature and the development of standards.
- Safety issues.
- The promotional aspect and media hype.

A major hurdle for the progress of the science is the development of a consistent nomenclature, Roco said. Nanotechnology is an intersection of many fields, each with its own language. “In order to take advantage of nanotechnology, we must work with

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other fields of relevance”, he said. Also, standards are needed. Currently, there is a race among three contenders—the United States, Europe, and China—to develop nanotechnology standards. This is very important because “how you measure what you measure will favor a certain industry and have economic implications”, he said.

Any new science must address the issues of quality and safety, Fleischer said. Regarding the latter issue, Roco noted that substances on a nano scale often behave differently from substances in bulk form. For example, a bulk substance that is inert, such as gold, will conduct electricity on the nano scale. So there are a lot of unanswered questions, including those that deal with safety, he said. But safety depends on terminology because without a consistent nomenclature, standardized safety testing is impossible.<sup>6,9</sup>

Von Her commented about promotional issues surrounding nanotechnology, stating that editors should watch for instances where people use *nano* simply to “jazz up what they’ve always been doing”. He advised digging beneath this “veneer of new”. But he also cautioned against “crusty old sages’ denouncing the new upstarts” as a means of keeping the establishment safe so that they can continue to do things in the same way. “Everybody started out as an unknown”, so do not discount someone just because he or she is not yet “a marquis chaired professor with a huge publication list”, he said.

### Views on Journals: From the Editors

Another major consideration is whether new journals are needed to accommodate this science. Blume said that “with things like this, many publishers will launch journals that are ‘niche’ journals. Our response [that of the journals of the American Physical Society] to this is to provide virtual journals, such as *The Virtual Journal of Nanoscale Science and Technology* ([www.vjnano.org/nano](http://www.vjnano.org/nano)), as a place where researchers can publish quality papers. This way, the authors will still be able to get the exposure that they would get in a

niche journal.”

Others, however, have opted for new journals. Elsevier launched *Nanomedicine: Nanotechnology, Biology, and Medicine* in March 2005. Executive Editor Yih said that, for the survival of a high-technology journal, such as those in nanotechnology, editors must do the following:

- Be knowledgeable in nano-related fields and keep up with the latest trends and developments.
- Familiarize themselves with funding opportunities, including those in foreign countries.
- Be able to project at least the short-term direction for the next 3 to 5 years.
- Ask for expert opinions.

Yih said that when a “well-funded, state-of-the-art, emerging technologic field has been unveiled”, such as nanotechnology, it is to be expected that industry and researchers will focus resources in it. “That’s where the money is—including venture capital and potential high-risk, high-payoff returns—and of course, more opportunities are in there, too.”

Vayssieres, a senior research scientist and editor-in-chief of the *International Journal of Nanotechnology* (launched in 2003), is an invited speaker at many international conferences, and this gives him the opportunity to identify high-quality research, he said. He uses that information to invite the scientists to submit their work to the journal. He believes that the best way to avoid the hype surrounding nanotechnology is to have a “broad and deep knowledge in nanotechnology and its related fields”. Editors should look for “quality, novelty, originality, simplicity, and accuracy of the data and relevance of the discussion and arguments”.

### Conclusions

Developments in nanotechnology, Roco said, will have a major effect on the life sciences and medicine because “it allows a basic understanding of what had been empirical”.

But, at this point, results are needed for the movement and its funding to continue, he cautioned. Yih echoed

similar sentiments: “Right now, we’re in a bottleneck. There is a desperate need to have a breakthrough to refuel this field.” He added that “people have to be a little patient”, but unless a significant scientific or technologic breakthrough occurs, the popularity of nanotechnology—and thus its funding—may last only another 3 to 5 years.

All said that it is possible that nano will end up being a big waste of time and money.<sup>4</sup> Blume stated that “the real unsung heroes are the ones that said ‘It couldn’t be done’, and it really couldn’t be done”. Here, again, editors will play a crucial role in ensuring that information that comes to the fore is properly vetted in a rigorous scientific way. 

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