Is Nano a Bubble?

Every day, we hear about a bubble in a national economy or a housing market and governmental attempts to slow or to relax this uncontrolled expansion before they violently collapse. However, bubbles are ubiquitous, and we should also ask: are nanoscience and nanotechnology bubbles, and if so, how can we avoid such a violent collapse?

In introductory physics, we learn that an oscillation requires an accelerating force and an opposing force. A frictional force that increases with velocity is required to reduce the oscillation amplitude. A key task of an engineer or a scientist working in a new (or popular) area is then to tune this friction to be small enough to obtain a new equilibrium state and high enough to avoid many overshoots. Otherwise, hype leads to the catastrophic collapses that we have experienced in recent economic and housing crises.

This level of realism and self-criticism is essential for our field and for our multidisciplinary audience.

Many of us have experienced bubbles in science. Fifty years ago, a paper postulated a new mechanism to achieve a superconducting transition in an organic material at about 2000 K.[1] This target was later reduced for specific cases, but superconductivity above room temperature has remained a dream. It stimulated much work with low-dimensional organic solids but soon went away and was replaced by work in organic electronics. Likewise, molecular electronics was poised to replace silicon but has not.[2] These activities have ultimately laid the groundwork for many modern applications, *e.g.*, in organic light-emitting diodes and organic photovoltaics[3] (we note that recombination luminescence in anthracene crystals was also reported 50 years ago[4]).

How about bubbles in nanoscience and nanotechnology? We all have visions and expectations for our work and field, so the "acceleration force" is huge. Nanotechnology is not new, if we think back, for example, to the photographic industry, which understood much about charge injection into Ag particles and made use of it at enormous production levels. They did not have the tools we now have for rational design in terms of synthesis, characterization, and computing. Difficulties with the latter are often opposing forces, which become weaker because of the fast development of these tools.[5] What about the friction forces, and why are there not many nano products on the market?[6]

Many scientific articles, including reviews, are written as if funding agencies were the audience. There is typically great potential, a problem that is solved, but little mention of further problems to be addressed. These issues are the friction, which are often kept low, perhaps to please those who could support further work. Note that we specifically ask our authors to lay out challenges and opportunities ahead, in research articles and also especially in Perspective,

Published online October 27, 2015
10.1021/acsnano.5b06393

Nano Focus, and Review articles. We feel that these levels of realism and self-criticism are essential for our field and for our multidisciplinary audience. It is one of the contributions of our editors, advisory board, authors, referees, and readers to prevent uncontrolled expansion of hype and bursting bubbles. This issue was discussed among global leaders in nanoscience and nanotechnology this fall,[7] with the consensus that it is also important to edit the press releases that are disseminated about our work. These pieces seek to capture public attention but must honestly represent our work and our field (how many times has cancer been cured in press releases?).

Nanoscience and nanotechnology do not have a single goal or application so, in a sense, many bubbles can form. At *ACS Nano*, we link these areas together with a common platform and a common audience. In this tempered expansion, as in other areas, we can learn from each other. We, as a community, are able to control bubble size and decay. Let us work together to make our field like a fine champagne, where time, care, and aromatic and flavorful effervescence lead to something beautiful that stands the test of time.

Disclosure: Views expressed in this editorial are those of the authors and not necessarily the views of the ACS.

Acknowledgment. We thank Ms. Holly Bunje for help in the preparation of this editorial.

Helmuth Möhwald
Associate Editor

Paul S. Weiss
Editor-in-Chief

REFERENCES AND NOTES

1. Little, W. A. Possibility of Synthesizing an Organic Superconductor. *Phys. Rev.* **1964**, *134*, A1416–A1424.
2. Service, R. F. Breakthrough of the Year: Molecules Get Wired. *Science* **2001**, *294*, 2442–2443.
3. MacDiarmid, A. G. Synthetic Metals: A Novel Role for Organic Polymers (Nobel Lecture). *Angew. Chem., Int. Ed.* **2001**, *40*, 2581–2590.
4. Helfrich, W.; Schneider, W. G. Recombination Radiation in Anthracene Crystals. *Phys. Rev. Lett.* **1965**, *14*, 229–231.
5. Weiss, P. S. New Tools Lead to New Science. *ACS Nano* **2012**, *6*, 1877–1879.
6. Weiss, P. S. Where Are the Products of Nanotechnology? *ACS Nano* **2015**, *9*, 3397–3398.
7. Hersam, M. C.; Lee, S. T.; Nel, A. E.; Rogach, A.; Buriak, J. M.; Weiss, P. S. Big Roles for Nanocenters. *ACS Nano* **2015**, *9*, 8639–8640.