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Commentary on Nanochemistry

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Commentary

Nanochemistry should not be defined only in terms of a length scale; such a definition would miss much of the conceptual novelty and diversity of nanochemistry. An educational way to define this field is instead through those concepts, ideas, and tools that, taken together, distinguish nanoscience from the rest of chemistry and physics. The goal of this chapter is to introduce those concepts. The approach we adopted to introduce you to this subject is multidisciplinary; the concepts presented should be amenable to teachers and students from chemical and physical, materials science and engineering, and biological and medical disciplines. A physicist, for example, will be able to teach the principles and practice of nanochemistry to a group of physics students using the road map we delineate, but using the language of physics.

Nanoscience students from other disciplines in such a class will all benefit from the more analytical physics approach to nanomaterials, peppered with just the right amount of nanochemistry detail; the same can be said about teachers from the other science, engineering and biological backgrounds. This educational philosophy should be appealing to teachers from any discipline whose goal is to get across the basics of nanochemistry in a way that is tailored to both teacher and students. It is an experiment in teaching and learning the rudiments of nanoscience and nanotechnology through the chemistry of nanomaterials, where the nano food chain begins, and in which we are all guinea pigs. The challenge of teaching nanochemistry lies in its diversity. Its topics and objectives often seem unrelated.

Discovering its intimate connections is much like traveling to the home of an ancient culture, where every town has its own traditions, habits, foods, and dialects. It takes years even to get a glimpse of the spirit of a nation. This learning curve can be eased by giving you the tools with which to divide a nanochemistry problem into its simplest components. These tools are few, and intimately but subtly connected. In this book you will see these connections and thus hopefully the solutions, the possibilities, and the marvelous diversity this field encompasses. The price to pay forth is shortcut is that the tools are rather conceptual in nature. You will not find details here. You will not find mathematical proofs either. You will find instead a concentrate of ideas, some a little philosophical, and many unlike anything you are used to from a scientific textbook. We have done our best to ease your way through, but only so much help can be effective.

One nanometer (or one nm) is 1×10^{-9} meter. As a frame of reference, a piece of human hair is about one hundred thousand nanometers thick. Any material that is at least one dimension measuring 1-100 nm can be considered a nanomaterial. For instance, consider cutting a watermelon. When you slice the watermelon, two surfaces are generated from the first cut, leading to an increase of the total surface area. If the watermelon is cut continuously into nano-sized materials, i.e., nanomaterials, the total surface area would become huge.

Dr. Richard Phillips Feynman was an American theoretical physicist and a Noble laureate. Feynman's notion that "there's plenty of room at the bottom," has swung open the door to nanochemistry and has inspired scientists to relentlessly explore this field.

At its core, chemistry with nanotechnology is all about doing more with less material. Therefore, nanochemistry is vital to the sustainable development of our economy and society. I've come to see the importance of nanochemistry first-hand in my research regarding battery materials. Let me explain. The natural reserves for these materials keep decreasing due to the wide use of battery-powered electronics. But the demand for batteries continues to increase while their prices are simultaneously expected to decrease. Nanotechnology plays and will continue to play a major role in combating the conventional wisdom of high demand leading to high price.

Future of Nanochemistry

Because nanomaterials can significantly improve properties/functions of an object, I hope to see this technology used more going forward. But in order for more nanomaterials to be moved out of laboratories and into the market, many parties have a role to play:

- First and foremost, it is the role of a nanochemist to achieve facile and tailored syntheses of nanomaterials with desired functions at a low cost.
- Because nanoscience is an interdisciplinary field, scientists from various fields, such as physics and biology, need to work together to achieve the goals.
- And finally, the general public and policymakers should give their input regarding the commercialization and utilization of nanotechnology.

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