Materials Chemistry—A New Subdiscipline?

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As editor of the journal *Chemistry of Materials* and co-chair of an upcoming American Chemical Society (ACS) symposium, "Materials Chemistry—A New Subdiscipline," I am often asked, "What is materials chemistry?" Is it really a new subdiscipline or just another name for what chemists have always done? Materials chemistry, which I would define as *chemistry directed at the* ***preparation, processing, and analysis*** *of materials,* does include activities that have always been a part of chemistry, but these activities are now being viewed as components of a new subdiscipline.

Preparation: Since its emergence as a distinct discipline from the alchemy of the Middle Ages, chemistry has been intimately involved in the search for new materials. In recent times, basic and applied research in chemistry has generated a wide range of materials (e.g., nylon) that have become part of the "fabric" of modern society. Chemistry's role in generating new materials continues at an ever increasing pace, yielding new polymers, organic and inorganic solids, liquid crystals, composite materials, and even new forms of carbon.

Processing: Chemistry has long served as a means to "process" known materials to enhance their utility, as in tanning leather, dyeing fabrics, painting surfaces, or anodizing aluminum. However, recent research has given new meaning to "materials processing" and has also led to whole new technologies. Known materials have been generated in entirely new forms, such as Si integrated circuits, epitaxial GaAs films, silica "aerogels," and continuous "SiC" fiber.

Analysis: The analysis of materials includes everything from characterization of the structure (microscopic and macroscopic) and properties of materials to the theoretical interpretation of behavior.

Despite the obvious interdependance of chemistry and materials science, and the fact that a large fraction (33%) of employed chemists are estimated to work in materials,[1] the academic chemistry profession has only recently acknowledged this connection and taken up the challenges of modern materials technology. In the last few years, several universities have included materials-related subjects such as solid-state chemistry in the undergraduate chemistry curriculum and have experimented with materials-oriented freshman chemistry courses. At my own institution, chemistry and materials engineering faculty have jointly developed a two-semester sequence, Chemistry of Materials, to replace Chemistry I and Materials I for freshman engineering majors.[2] In graduate education and research, interest in materials chemistry has grown more quickly, fueling the rapid increase in materials science publications worldwide. *Chemical Abstracts* recorded increases of 34 to 70% in materials-related abstracts in just the past five years.

Within the chemistry profession, the last five years have also seen a major increase in materials-related research as well as a growing recognition of materials chemistry as a distinct area. The journal *Chemistry of Materials* was introduced by ACS in 1989 and the *Journal of Materials Chemistry* by the Royal Society of Chemistry in 1991. Judging from the success of these two journals and the wealth of new ideas and materials reported there and in other chemistry journals, "materials chemistry" is rapidly becoming an important research area for many chemists. The ACS has recently established a "Materials Chemistry Secretariat." A consortium of 11 Subject Divisions that will coordinate meeting programs and other activities in materials chemistry.

This growth in materials chemistry research appears to be building on long-term strengths within the chemistry community in areas such as polymer and solid-state chemistry. However, there is also evidence of an increasing number of "conversions" to materials chemistry by individuals trained in the more traditional areas of chemistry.

It is apparent that materials chemistry has been in existence for many years, but it is only now becoming recognized as a distinct subdiscipline. As such, it encompasses not only the well-established materials-related areas of polymer and inorganic solid-state chemistry, but also many aspects of surface chemistry, organic solid-state chemistry, sol-gel chemistry, ceramic precursors, MOCVD, and nanoscale materials synthesis, among many others. The common interest in chemistry related to the preparation, processing, and analysis of materials unifies these historically separate activities and justifies their designation as a distinct subdiscipline. A materials chemistry subdiscipline combines these areas in a way that makes sense from both operational and educational viewpoints. Many concepts related to structure, bonding, and properties are common to materials comprised of organic molecules, inorganic networks or polymeric chains, and an integrated perspective could aid both fundamental understanding and practical applications of new materials.

This is not to say that chemists working in isolation are likely to make major technological advances in materials science. Long-term progress in materials science will depend on the cooperative interaction of individuals from various disciplines. The development, within the chemistry profession, of a better understanding of materials science and its relationship to chemistry, though, is clearly the first step in getting chemists to interact with materials scientists and engineers.

Establishing a materials chemistry subdiscipline will increase the participation of chemists in materials-related research and also foster a broader education of chemists on materials science issues. Chemists will be better prepared to undertake the challenges of materials technology and interact with other materials scientists/engineers in industry and academia. Increasingly effective communication between chemists and materials scientists/engineers is the inevitable outcome.

1. *Materials Science and Engineering for the 1990s: Maintaining Competitiveness in the Age of Materials* (Natl. Acad. Press, Washington, DC, 1989); *Report on the NSF Undergraduate Curriculum Development Workshop in Materials* (NSF-9O-6O, April 1990); *MRS Bulletin* **XV** (8) (1990) p. 54-56.

2. G.E. Wnek and P.J. Ficalora, "Relating the Macroscopic to the Microscopic," *ChemTech,* November 1991.

3. *MRS Bulletin* **XVI** (10) (1991) p. 16.

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