Richard Vaia

A long-term advocate of materials science and engineering

By **Humaira Taz**

When I think of materials science and engineering (MS&E), I think of it as a relatively new discipline—never quite sure if it is more physics, chemistry, math, or engineering. Truth be told, it is a combination of all of these diverse fields and many more. It touches all parts of 21st century life, from clean energy, telecommunications, and information, to health care, transportation, and defense. Also, it is not as new as I thought—people have been studying MS&E since the early 1960s, and the discovery, use, and manufacture of new materials are arguably as old as human civilization, providing the foundation to the Stone, Bronze, and Iron Ages! Richard Vaia, the US Air Force Senior Scientist for Emergent Materials, is one of MS&E's pioneers.

Vaia completed his bachelor's education in materials in 1991 at Cornell University, after selecting the school based on its MS&E program. "The department had a feeling of excitement. It seemed that everything depended on materials; technologies were limited by materials and processing; and future innovations were going to come from new materials. This spanned from electronics, to aerospace, to the chemical industry, polymers, and medicine," said Rich.

Rich's interest in MS&E came from a combination of his father's work as a metallurgist for Westinghouse and his fascination with math and science classes throughout high school. His career at the US Air Force Research Lab (AFRL) is a direct result of his passion for new materials and their applications in cutting-edge technologies. "It works at the intersection of all types of materials, all types of aerospace systems, and problems that span from fundamental research to challenges to our current systems. Daily we interface and collaborate with global leaders, from academia, industry, and our Nation's warfighters," he said.

Regarding the evolution of MS&E during the last two decades, materials are the "stuff" that enable new components for future technology. "It is these new abilities in the innovator's tool box that expand creativity and create new markets and technologies—it is what enables science fiction to become everyday fact." MS&E's scientific core, and what it brings to materials R&D, is a fundamental understanding of the interrelationships among composition, processing, and structure and how these affect properties, performance, and manufacturability. The biggest change to MS&E is the infusion of tools from different disciplines. "Activities and practices, such as big data, analytics, robotics, autonomy, artificial intelligence, and biotechnology will move to the center of MS&E. The "how" MS&E is done today, and will be done in even two years, is drastically different from 10 or even five years ago," Rich concluded.

While the change in "how" MS&E is done is a positive step, it can simultaneously be a challenge. "The field must ensure its future leaders not only understand the fundamentals of structure–processing–composition relationships, but are proficient in utilizing the new tools of information technology," said Rich. The second challenge is for MS&E to lead the materials R&D community in radically increasing the speed at which new materials are risk-reduced. It typically takes 20–40 years for a new material to go from discovery to large-scale commercial use. This timeline is not viable—lots of potential is left on the shelf. Rich commented that maybe "the emergence of customizable manufacturing processes will merge digital design, additive concepts, and real-time autonomous process control and facilitate this acceleration by enabling the acceptance of greater risk than can be justified in conventional mass production."

His advice to students in materials science is to work at the convergence of other fields and experts. "Always think and ask about context—how else can this be done, what are the other competing concepts, how do different fields look at the problem, are there non-materials solutions, do different applications have different requirement sets, etc. I believe, more than ever, the key to future scientific discovery and technology innovation will be the uniqueness and breadth of the team's diversity; it is all about the teams," he said.

To that end, he highlighted how in his early years, *MRS Bulletin* was the main source of cross-disciplinary perspective and overview on new materials and techniques. Rich has held multiple positions at MRS—starting as a student volunteer, to Meeting chair, working with publications, and providing leadership as a member of the Board of Directors. He stressed how his experiences at MRS—the opportunities to engage and interact with people from widely different backgrounds—have been critical in his professional growth.

Between his job at AFRL and his commitment to MRS, he enjoys outdoor activities with his family, such as running, hiking, biking, skiing, and water skiing.

When I asked about what he was most proud of in his career, he discussed the success of the various teams and activities he has worked on. "I find it immensely satisfying to be part of a high-functioning team, tackling hard problems, and delivering solutions that make a difference. I have been fortunate to have been part of many such teams from my own research group in polymer nanomaterials, to AFRL, and MRS." Talking to Rich not only refueled my own passion for materials research, but also made me realize how rewarding it is to work in a field you love. □

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