2020 MRS Communications Lecture: Machine learning for composite materials

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Video Abstract

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Abstract

The Materials Research Society is proud to announce the 2020 MRS Communications Lecture honorees, Drs. Chun-Teh Chen and Grace Gu from the University of California, Berkeley. The honor recognizes excellence in the field of materials research through work published in MRS Communications. Drs. Chen and Gu are recognized this year for their prospective paper on how researchers are harnessing artificial intelligence to accelerate the design and discovery of composite materials. Their work is featured in volume nine, issue two of MRS Communications. Composites are combinations of two or more base materials, whose collective properties exceed those possessed by either material alone. Composites are widely used as structural materials in the automotive and aerospace industries and can also be easily found in nature. Limitations in manufacturing methods have generally restricted the architecture these materials take on in real-world applications. Most commonly, they're processed into multilayer sheets. But with advances in techniques such as 3D printing, composites can take on entirely new and complex shapes. While this newfound freedom makes room for researchers to create composites with superior properties, it also opens up an even bigger challenge: How can researchers get more out of composites? And what combinations of composition and structure are possible but have yet to be discovered? That's where artificial intelligence provides a much-needed assist. Machine learning methods offer the capacity to screen vast numbers of materials combinations to suit virtually any application. Traditional materials discovery is a long and incremental process. Scientists and engineers must rely on intuition (and sometimes luck) just to get started. Testing only comes after a thorough vetting of possible combinations. And even then, the discovery of a new and useful composite isn't guaranteed. Using machine learning methods, researchers can probe this vast space of would-be materials faster than ever. Instead of relying on intuition alone, they can leverage the processing power of today's computers to find otherwise invisible patterns in raw lab data. Already, researchers are using machine learning to discover new materials. For instance, researchers have used an iterative screening process to search for high-performing forms of graphene that resemble origami. And Dr. Gu and colleagues have used convolutional neural networks to design composites for strength and toughness. One challenge that remains in this growing field is developing more efficient search techniques that yield high-performing candidate materials without exploring the entire design space. Still, machine learning is proving to be a powerful part of the materials researcher's toolkit. And it will likely only get better. As Drs. Chen and Gu highlight in their paper, machine learning stands to revolutionize approaches to the design and optimization of composites, making room for the next generation of materials with unprecedented properties.