Towards Next Generation of Architected Materials: Design for Fracture Resistance

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November 9, 2022, 11:00am, 2004 Black Eng.

Abstract:
Heterogeneous materials such as carbon fiber-reinforced polymer composites represent the future of engineering materials with unprecedented mechanical performance. The architecture in which the constitutive materials are arranged is the key determinant of their performance. Designing heterogeneous materials for extreme conditions such as failure and fracture resistance remains a huge challenge not only because of the complexity of fracture modeling, but also the infinite possible architectures and combinations of materials. These difficulties in practice necessitate powerful and efficient numerical design approaches.

This talk will present key findings from my research on design for fracture resistance of heterogeneous architected materials. Approaches vary from strength-oriented optimization on “one-shot” fracture to controlling structural degradation in successive phases—from damage initiation to multiple crack propagation and ultimately to failure. I will summarize the qualities of biomimetic, gradient-free, and gradient-optimized architectures for enhancing mechanical fracture performance. New results on leveraging reduced-order modeling and data-driven methodologies will be demonstrated. Ultimately, I will offer a description of my long-term vision for architected materials design that spans multiple disciplines.

Biography:
Daicong Da is currently a postdoctoral scholar in the department of mechanical engineering at Northwestern University. He received his Ph.D. from the Université Paris-Est, France in 2019. Before joining Northwestern, he was a Research Associate at the University of Wisconsin-Madison. His current research interests deal with mechanics of materials, design optimization, and data-driven paradigm, with applications to advanced manufacturing, soft robotics, and multifunctional materials and structures. He is the author of the book “Topological Design Optimization of Heterogeneous Materials and Structures” by John Wiley & Sons, has published 25+ peer-reviewed papers in leading journals in his field, and has presented at dozens of academic conferences. He has won several awards including a Best PhD Award for Melosh Finalist, a USNCCM16 Conference Award, NSF-NCTAM Early Career Attendee Fellowships, and a Travel Award for MMM10. He is a member of the American Society of Mechanical Engineers (ASME), the U.S. Association for Computational Mechanics (USACM), the International Association for Advanced Materials (IAAM), and the International Society for Structural and Multidisciplinary Optimization (ISSMO), etc. He has served as session chairman for the largest international conferences in his field and manuscript-reviewer for 25 academic journals.

***This seminar counts towards the ME 600 seminar requirement for Mechanical Engineering graduate students.**
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