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Tal Cohen

Associate Professor of Civil and Environmental Engineering

Associate Professor of Mechanical Engineering

MIT

Cavitation: at interfaces, with bacterial colonies, and in our bodies

ABSTRACT:

Cavitation has long been recognized as a crucial predictor, or precursor, to the ultimate failure of various materials, ranging from ductile metals to soft and biological materials. Traditionally, cavitation in solids is defined as an unstable expansion of a void or a defect within a material. The critical applied load needed to trigger this instability -- the critical pressure -- is a lengthscale independent material property and has been predicted by numerous theoretical studies for a breadth of constitutive models. In this talk, I will discuss our recent advancements in the study and application of cavitation in solids. In the first part of the talk, a theoretical model of 'interfacial cavitation' will be complemented by experimental observations at different scales to establish an analogy to the commonly studied bulk cavitation phenomena and the ensuing propagation of interfacial failure. In the second part of the talk, I will describe our recent work on Volume Controlled Cavity Expansion (VCCE). A method that, via needle induced fluid injection, allows us to study local material properties and the transition between cavity expansion and fracture. We will discuss various applications that emerge from this work, including its implications for our understanding of the evolution and resilience of bacterial colonies, and the unique mechanical response of blood clots. Finally, I will briefly describe our ongoing efforts to implement this work for the diagnosis of cancer.

BIOGRAPHY:

Tal Cohen is an Associate Professor at MIT. She joined the Department of Civil & Environmental Engineering in November 2016 and has a joint appointment in the Department of Mechanical Engineering. She received both her MSc and PhD degrees in Aerospace Engineering at the Technion in Israel. Following her graduate studies, Tal was a postdoctoral fellow for two years at the Department of Mechanical Engineering at MIT and continued for an additional postdoctoral period at the School of Engineering and Applied Sciences at Harvard University. She received the ONR young investigator award and the NSF CAREER award in 2020, and the ARO young investigator award in 2019. Earlier awards include the MIT-Technion postdoctoral fellowship, and the Zonta International Amelia Earhart Fellowship. Her research is broadly aimed at understanding the nonlinear mechanical behavior and constitutive sensitivity of solids. This includes behavior under extreme loading conditions, involving propagation of shock waves and dynamic cavitation, material instabilities, and chemo-mechanically coupled phenomena, such as material growth.