Microscopic and macroscopic instability analysis of magnetoactive soft composites

Chen Xie*[1], Nitesh Arora[2,3], and Stephan Rudykh†[4]

[1]University of Galway – Ireland
[2]University of Wisconsin, Madison – United States
[3]Georgia Institute of Technology [Atlanta] – United States
[4]University of Galway – Ireland

Abstract

This study investigates the structural instability of magnetoactive soft composites under coupled mechanical and magnetic fields. Analytical and numerical models are developed using hyperelastic magnetic frameworks, including the Neo-Hookean model combined with linear soft and hard magnetic assumptions. Critical behavior in the analytical models is determined by detecting the loss of ellipticity. By considering two distinct definitions of magnetization in the reference configuration, the transition points between microscopic and macroscopic instability modes are identified. Post-buckling analysis is performed to predict instability onsets by adding small geometric imperfections in the microstructure through finite element simulations. To enable effective and remote control of these composites, the influence of external magnetic fields, remanent magnetization, volume fraction, and microstructural parameters on magneto-mechanical instabilities is systematically examined.

*Speaker
†Corresponding author: stephan.rudykh@universityofgalway.ie