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Building Tiny Machines: The Role of Mathematics

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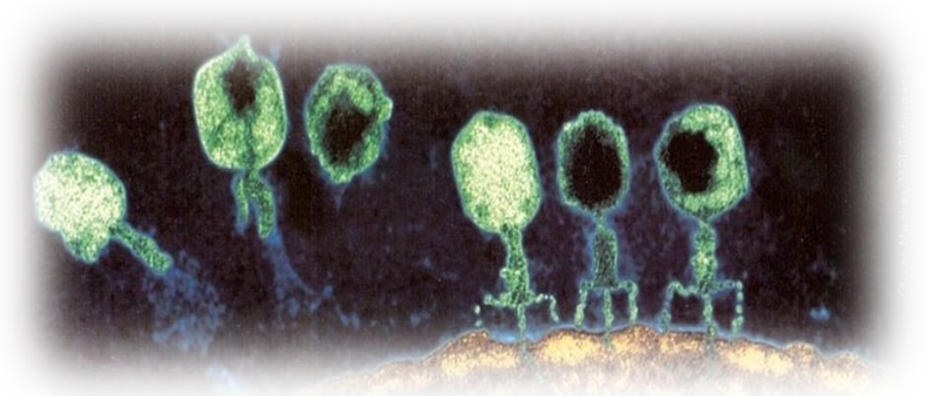
During the last several decades mathematics has guided the discovery of new materials using rigorous principles that in a few instances have challenged well-established beliefs in materials science. In turn, the striking beauty and order of material microstructure and the extreme nonlinearity and nonconvexity of the elastic energies behind a host of observed physical phenomena have inspired a great deal of new mathematics in areas ranging from calculus of variations and partial differential equations to differential geometry, topology, and harmonic analysis.

Perhaps one of the best examples of the fertile interaction between mathematics and materials science is the study of phase transformations in materials. This talk will focus on the martensitic phase transformation, whose key manifestation can be seen best in the shape memory effect - a phenomenon observed in certain metallic alloys, ceramics, and even biological systems. Due to their technological applications as microactuators, whose development is one of the challenges in the design of micromachines, or MEMS (microelectromechanical systems), martensitic thin films that exploit the shape memory effect have been intensively studied by scientists trained on both sides of the rapidly expanding interface between mathematics and materials science. I will give an introduction to this fascinating interdisciplinary area of research, with an emphasis on the role of mathematical analysis in the effort, motivated by a number of potential applications, to understand how effective thin film models for the design of MEMS can be derived from three-dimensional nonlinear elasticity.



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Marian Bocea is an Associate Professor of Mathematics at Loyola University Chicago. He received B.Sc., M.Sc., and Ph.D. degrees in Mathematics from University of Craiova, Romania, and also holds M.Sc. and Ph.D. degrees in Mathematical Sciences from Carnegie Mellon University, USA. Marian's research interests are in PDEs, Calculus of Variations, and their applications to Materials Science. His work has been continuously funded by the U.S. National Science Foundation since 2008.

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