The Beams and Applications Seminar Series

Design and optimization of material and devices via multiphysics FEM simulations in MEMS and nanotechnology

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Bldg. 401, Room B-2100
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Abstract:

Modeling and simulation of the physical behavior of materials and/or optimization of MEMS devices is vitally important to design and develop innovative products, and is also important to reduce time to deploy technology and expenditure of the process. This presentation discusses steady state and transient simulations of pH-sensitive hydrogels, a MEMS hybrid actuator, and micro fluidics devices utilizing a multi-physics approach that couples various partial differential equations.

The transient swelling behavior of a pH-sensitive hydrogel is simulated using an approach that fully couples the chemo-electro-mechanical effects for a 3-dimensional finite element model. The results of the finite element method simulation are based on three nonlinear, partial differential equations that represent three distinct physical phenomena responsible for the swelling behavior. The results of the simulated swelling behavior are compared with published experimental results.

Development of a hybrid device is discussed. Actuation is achieved by the combined effect of thermal expansion, electromagnetic force, and magnetostatic force. The proof of concept was tested initially followed by optimization of design parameters on basis of minimum power consumption and large actuation. This MEMS device consists of two arms of the actuator, a perm-alloy core, an electromagnetic coil and a permanent magnet.

The third part of the presentation covers development of microfludics devices to be used for in situ analyzing polymer nanocomposite particles for USAXS study at sector 15. All simulations were performed for coupled system of equations.

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