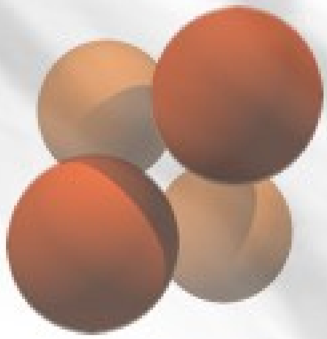

MSE SEMINAR

Materials Science and Engineering
Michigan Technological University

Tuesday, March 31, 2015
11:00 am – 12:00 pm
Room 610, M&M Building

Magnetic Nanowires: Revolutionizing Hard Drives, RAM, and Cancer Treatment

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Abstract

Magnetic nanowires can have many names: bits, sensors, heads, artificial cilia, sensors, and nano-bots. These applications require nanometer control of dimensions, while incorporating various metals and alloys. To realize this control, our 7- to 200-nm diameter nanowires are synthesized within insulating matrices by direct electrochemistry, which negates sidewall damage such as that caused by lithographical patterning of vacuum-deposited structures. Our nanowires can easily have lengths 10,000x their diameters, and they are often layered with magnetic (Co, Fe, FeGa, FeNi, Ni) and non-magnetic (Ag, Cu, Au) metals as required by each application. This talk will reveal synthesis secrets for nm-control of layer thicknesses, even for difficult alloys, which has enabled studies of magnetization reversal, magneto-elasticity, giant magnetoresistance (GMR), and spin transfer torque (STT) switching. In addition, this lithography-free synthesis yields 10-nm diameter nanowires that have resistivities of only 5.4u□ü cm (nearly that of bulk copper) due to negligible sidewall roughness. Therefore, these nanowires will mitigate the ITRS Roadmap's "Size Effect" Grand Challenge which identifies the high resistivities in small interconnects as a barrier to continued progress along Moore's Law (or better). Ten-nm diameter trilayers of [Co(15nm)/Cu(5nm)/Co(10nm)] have also met or surpassed all of the criterion for the world's smallest read heads with 30 Ω resistance and 19% magnetoresistance. High magnetoresistance is also possible in other multilayered nanowires that exhibit excellent properties for mulit-level nonvolatile random access memory (RAM) using STT switching at very low current densities ($100kA/cm^2$). If the insulating growth matrix is etched away, the nanowires resemble a magnetic bed of nano-seaweed which enables microfluidic flow sensors and vibration sensors. Finally, we have incubated various nanowires with several healthy and cancerous cell lines, and find that they are readily internalized by all cell types thus far. Careful magnetic design of these "nano-bots" enables external steering, nano-barcode identification, and several modes of therapy. In short, by the end of this talk, I hope you will be convinced that magnetic nanowires can and will revolutionize hard drives, RAM, and cancer treatment.

Biography: Stadler received her B.S. from Case Western Reserve University in 1990, and her PhD from MIT in 1994. She was at the Air Force Rome Laboratory for a National Research Council postodoctoral fellowship before joining the Electrical and Computer Engineering department at the University of Minnesota, where she is also on the Graduate Faculty of Chemical Engineering and Materials Science. Her research has been awarded the NSF CAREER award and a McKnight Presidential Fellowship. She is active in the Materials Research Society, serving on their Board of Directors (2005-7), then as Secretary (2008-10), and now on the Program Development Subcommittee. She has won an Outstanding Mentor Award in the Presidential Mentor Program for Underrepresented Students and has taught "Nanomagnetics" for the IEEE Magnetic Summer School in Chennai India and in soon in Assis Italy.

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