

A New Interdisciplinary Engineering Course – “Nanoscale Transport Phenomena for Manufacturing Nanodevices”

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Commercialization of many “nanotechnology products” requires incorporating nanoscience discoveries into macro, micro, and nanoscale designs and manufacturing methods. There is, however, a large gap between nanoscience and commercial production of nanotechnology products. Nanoscience must be coupled with new nanomanufacturing science to create product prototypes and scalable manufacturing processes. Integration of the interdisciplinary knowledge required for designing and manufacturing nanodevices into undergraduate curricula remains a big challenge. To address this educational challenge and generate practical ways of introducing nanotechnology into undergraduate education with a focus on manufacturing nanodevices, five faculty from three engineering departments (Chemical, Mechanical and Plastics Engineering) have created an interdisciplinary course - "Nanoscale Transport Phenomena for Manufacturing Nanodevices", principles of nanoscale transport phenomena needed for manufacturing of nanodevices (Figure 1).

The course was offered for the first time as an elective to seniors in the University of Massachusetts Lowell's Francis College of Engineering in the fall semester of 2011. The course was presented through lectures, hands-on laboratory exercises, demonstration experiments, and a final design project. In this presentation, we will discuss the lecture topics and eight hands-on laboratory experiments or activities that have been developed into modules to complement respective lectures, including fluid mechanics, heat transfer, mixing, reaction engineering, electrophoresis, and manufacturing methods for micro and nanoscale devices. Figure 2 shows a lab module focused on the thermal conductivity measurement of nanofluids. We will also show the final project designs for the nanodevices or nanosystems that have been finished by student teams at the end of the course. Finally, we will show results of the pre-post student surveys as well as faculty interviews.

This new interdisciplinary course better prepares undergraduates for employment focused on designing and manufacturing nano/microfluidic systems, lab-on-a-chip devices, electronics devices, medical devices, and other emerging technologies. The impact of this senior-level course will significantly enhance the “Nanomaterials

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Engineering Option” in the Chemical Engineering Department undergraduate curriculum as well as the medical device industry focus in the Plastics Engineering Department, and can be used in the accelerated BS-MS program which is popular in the College of Engineering. The course will be available to the chemical, mechanical, and plastics engineering seniors each year. Our lab modules can also be exported to freshman introductory engineering courses in the College of Engineering. In addition, the microscale fluid mechanics and heat transfer experiments may be incorporated into the undergraduate chemical engineering Unit Operations Laboratory courses.

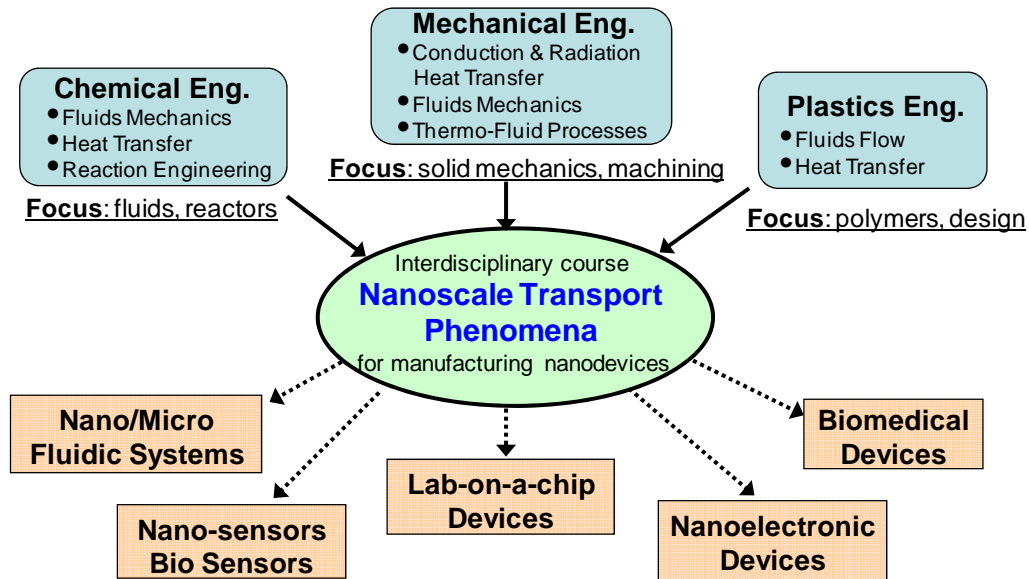


Figure 1: An Interdisciplinary Approach for the New Engineering Course in Nanoscale Transport Phenomena

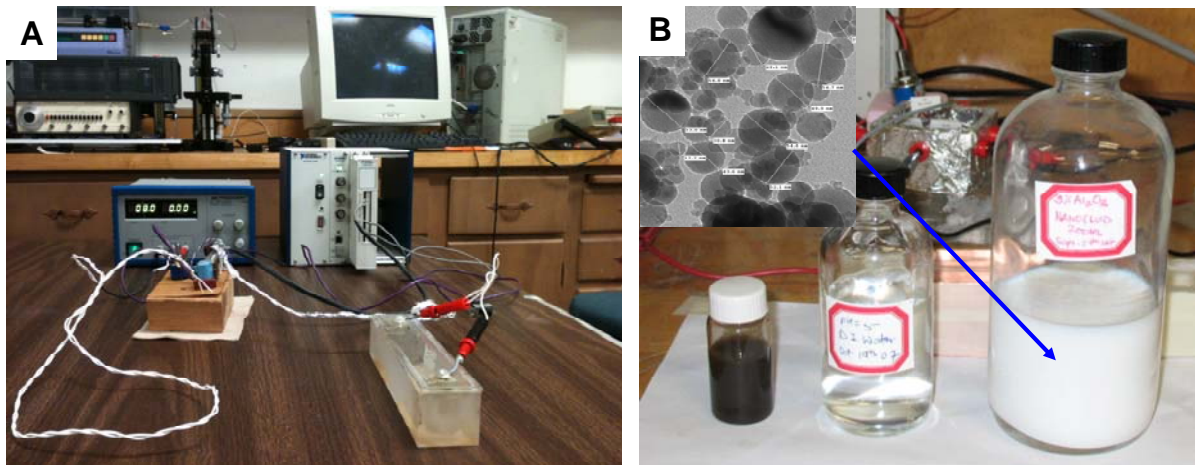


Figure 2: (A) Setup for measuring the thermal conductivity of nanofluids; (B) Al_2O_3 nanofluids (inset is an SEM image).

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