



## Research Assignment - 2009

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Title Professor/Professor

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Title of research assignment

### Evaluating the Effect of Polymer Substrate Type on the Transfer of CNTs

Research abstract

CHN has developed methods to assemble carbon nanotubes in micro and nanoscale patterns using "templates" and can transfer the patterned nanotubes to flexible substrates, thereby permitting reuse of the templates. The thermoforming process has been adapted to heat polymer sheets and assist with the transfer of carbon nanotubes. CHN researchers, however, still have little understanding of the parameters controlling the transfer process. Last year, RET researchers Ryan Hoffman and Mark Lawrence examined the effects of temperature and pressure for transfer using a compression molding process. Since then, UML graduate student Arun Kumar has repeated this determination for the thermoforming-based transfer process. In early transfer work using casting of polymer films, Ming Wei observed that polymer chemistry also affected transfer, but this aspect of transfer has not been examined in detail. The objective for this year's RET researchers would be to determine the effect of polymer chemistry on the transfer of carbon nanotubes using the thermoforming method.

#### Research activities/experience

The RET researchers will identify and obtain polymer sheet having a range of chemistries - as identified by nominal solubility parameters. They will characterize these sheets using contact angle measurements (surface tension) and differential scanning calorimetry (critical transition temperatures). The researchers will assemble nanotubes on templates using electrical forces; (the exact method depends on the template type). Then they will obtain the best conditions (and possibly the process windows) for transferring the carbon nanotubes to different polymer sheet; basically they will transfer the nanotubes and measure the results using optical and/or scanning electron microscopy. They will correlate the best transfer conditions to polymer properties (contact angles and solubility parameters). This work will be enable CHN to better select substrates for transferring nanoelements from our templates. - Arun Kumar and Ming Wei will be available to share their knowledge of the assembly and transfer process. UML has a large group working on assembly and transfer, including Ali, Arun, Jason, Jia, John, Liang, Ling-Ling, Mayur, Rinky, Satyam, Ming, JJ, and Jun. The Plastics Engineering Department also has lots of nice toys, like injection molding and blow molding machines, which the RET researchers can observe in operation.

#### Expectations of RET

The RET researchers will be expected to 1) observe all safety procedures required for the handling of carbon nanotubes and working in Plastics Engineering Department laboratories, 2) maintain laboratory notebooks, 3) coordinate with the other researchers in scheduling equipment - although they have some priorities, 4) attend scheduled group meetings, and 5) produce a final presentation (or poster). They are welcome to explore the University and discuss their research and the other students' research.

Special skills or interests that would help a RET participant with this assignment (i.e., an interest in physics, experience with specific laboratory equipment, etc.)

A knowledge of chemistry would be helpful, but the RET researchers just need to believe that plastics are fantastic!

Lab safety/issues unique to this laboratory. A general Lab Safety Overview will be presented by Environment Health and Safety to both RET and YSP participants prior to the beginning of lab assignments.

The RET researchers will be handling carbon nanotubes in solution, on the templates, and on the substrates. In these situations, the carbon nanotubes are not usually airborne, but UML will provide training and safety equipment for use in handling the nanoparticles. In addition, the plastic sheet will be heated to 100-200°F; thus, safety glasses (provided), slacks or long skirts, are no open-toed shoes are requirements in Plastics Engineering Department laboratories.

Suggested literature to be reviewed prior to beginning this research assignment.

We will provide information on polymers, thermoforming process, CHN assembly and transfer processes, and some prior papers on this topic.

Research/Lab Summer Hours : a.m. – : a.m.  Monday through Thursday  
 Monday through Friday

Scheduled Research/Lab Meetings : a.m. – : a.m.  Daily  Wednesday  To be determined  
 Monday  Thursday  
 Tuesday  Friday

Lab/research project URL

Not yet. Basic information on CHN is available at <http://www.nano.neu.edu>

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