הטכניון - מכון טכנולוגי לישראל
TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY

הפקולטה להנדסה כימית
ע״ש וולפסון
The Wolfson Department of Chemical Engineering

Wolfson Department of Chemical Engineering Seminar

Monday, November 11th, 2024 at 13:30

Room 4

Controlled Inorganic Growth within Polymeric Templates

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PhD Seminar

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Nanofabrication techniques are the enabling tools for creating devices in fields such as electronics, photonics, biotechnology, and energy by providing precise control over material properties and composition at the nanoscale. Central to nanofabrication is the conversion of polymeric patterns into inorganic ones. Directly transforming the polymer can offer greater tunability, simpler fabrication processes, and reduced costs compared to the existing methods. This can be performed with sequential infiltration synthesis (SIS), which uses gaseous precursors and atomic layer deposition (ALD) chemistry to grow inorganic materials within polymers. Following SIS growth in polymeric templates, the polymer can be removed, yielding polymer-templated inorganic nanostructures. Until now, SIS processes have been limited to using a single organometallic precursor at a time. However, utilizing multiple precursors while controlling their spatial distribution and concentration can open a path for fabricating multi-materials structures.

In this research, we introduce a novel technique for spatially controlled SIS, along with a method for controlling the concentration of each material when using more than one precursor. The growth location of each precursor within the polymer template is controlled by the precursors' diffusion time. We demonstrate this approach using a model system of cylinder-forming block copolymers (BCP), which templates an AlOx-ZnO heterostructure nanorod array. Additionally, we extend this technique to electrospun polymer fibers to create core-shell AlOx-ZnO ceramic fibers. By adjusting the SIS process parameters, we can control the size, morphology, and surface roughness of the fibers. Furthermore, we successfully fabricated Al-doped ZnO and AlOx-ZnO composites using SIS for the first time, achieving excellent control over concentration. To probe our samples, we employed scanning and transmission electron microscopy (SEM and TEM), including three-dimensional characterization through scanning TEM (STEM) tomography and energy-dispersive X-ray spectroscopy (EDS) STEM tomography. These new tools widen the SIS methodology, allowing its use across a broader range of applications.

Refreshments will be served at 13:15.