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|  |  | 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, September 23rd, 2024 at 13:30**

**Room 4**

**Hydrodynamic instabilities during polyamide synthesis and their impact on film morphology**

**Adi M. Ben-Zvi**

**PhD Seminar**

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My research focuses on the link between synthesis and morphology in polyamide membranes fabricated via interfacial polymerization (IP). Polyamide membranes are the state-of-the-art for reverse osmosis applications, removing >99% salt. This technology is widely used to treat unconventional water sources (e.g. seawater, wastewater) for drinking-water use, which is a necessity due to global potable water scarcity. However, while the performance of polyamide membranes has been improved since their invention over four decades ago, it has been through a ‘trial and error’ process, and the factors that control their performance, particularly synthesis conditions and film morphology, remained an enigma. Acquiring fundamental understanding of IP and focusing on synthesis-morphology-performance relationship is critical for controlling the reaction to design improved membranes and to move towards alternative, green materials.

We developed a framework to study synthesis-morphology relationship based on different instability mechanisms that may occur during the exothermic, rapid IP reaction. Our assumption is that a smooth membrane morphology is an outcome of a stable state, whereas a crumpled morphology is an outcome of unstable state of the IP reaction. We translated the various synthesis conditions to their physical attributes on the reaction and their effect on the instability state of the system, our conclusion is that when the polymerization rate increases as well as the tendency to instability, the morphology becomes more crumpled. To further study instabilities during the reaction, I designed a microfluidic device with a pinned interface to visualize and track fluorescent microparticles and study their motion during IP using confocal microscopy. We observed that when altering synthesis condition to achieve higher polymerization rate, the particles motion is more directed which serves as a proxy to the hydrodynamic instabilities, and the resultant film morphology is crumpled.

To better link film morphology to synthesis and performance, Electron Microscope Tomography (ET) techniques are used for 3D visualization. To date, only dry polyamide films have been visualized due to contrast limitations of the imaging, which is in stark contrast with the operational wet state of the desalination membrane. To address the morphological differences between a wet and dry state, we developed a novel method to visualize for the first time a hydrated polyamide film using cryo-ET. The results show significant morphological changes upon swelling of polyamide membranes, that may have a major effect on membrane performance. **Revealing the true governing mechanism that affect desalination membrane morphology and to characterize the morphology in close-to-functional state would pave the way towards a smart membrane design with adequate nanostructure and morphology for next-generation high performance membranes.**

Refreshments will be served at 13:15.