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
Wolfson Department of Chemical Engineering,
Wednesday, September 30th, 2020 at 13:30

Online seminar via Zoom
https://technion.zoom.us/j/98183031130

Dewetting of polymer films in non-solvent - solvent environment New approach for polymer patterning

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MSc Seminar

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Dewetting of polymers is a central phenomenon in polymer thin films which can affect films' stability and morphology. On the other hand, dewetting can also be harnessed for patterning micro and nano features with controlled dimensions and order. Dewetting of polymer thin film occurs due to the film's instability and typically begins with the film rupture and formation of holes; the holes continue to grow until they collapse and create small droplets. The phenomenon of dewetting induced by thermal treatment or solvent vapors has been studied extensively in a variety of polymers over the past years. Unlike these common dewetting paths, there is a knowledge gap in the field of dewetting of thin polymer films in an environment that combines both solvent and non-solvent.

In this research, we studied the dewetting process of polystyrene and polymethyl methacrylate thin films after immersion of the polymer films in non-solvent and exposure to solvent vapors, creating solvent non-solvent environment. In such systems, the presence of non-solvent increases the destabilizing force and reduces the spreading parameter, causing changes in the dewetting rate and in the polymer's final morphology. In non-solvent – solvent environment the dewetting rate is extremely fast and ends with significantly lower dimensions of the polymer droplets compared to polymer film dewetting under solvent vapors or thermal treatment. In addition, the final contact angle of the polymer with the substrate is considerably higher, which gives the droplets a spherical structure.

With the knowledge obtained on polymer dewetting in non-solvent – solvent environment, we introduced a simple and low-cost process which enables fabrication of long-range order polymer spheres patterns in the macro and nano scales. The process, which is based on directed polymer solution evaporation to form polymer lines, followed by dewetting, is spontaneous and does not require any manipulation on the substrate surface. We then utilized sequential infiltration synthesis (SIS) to selectively grow inorganic materials within the polymer spheres, forming hybrid and inorganic structures, which gives functionality and stability to the aligned patterns.