Characterizing Nanopattern Formation of Polymer Thin Films on Silicon Substrates with Ion Beam Sputtering+

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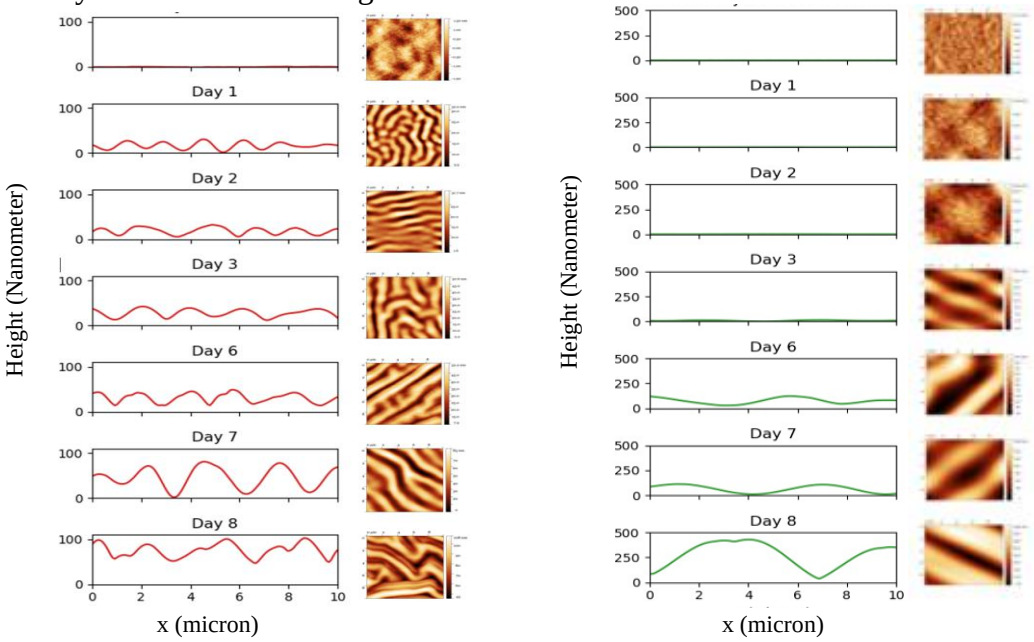
Surface nano-patterns formed by ion beam sputtering (IBS) have been reported by many research groups with most focus on semiconductor and metal materials [1]. However, limited study has been conducted on polymer nanopatterning introduced by IBS [2]. This study aims to understand polymer film wrinkling in relation to ion beams and humidity conditions, which could potentially introduce effective methods of tuning chemical and physical characteristics of polymer film surfaces. Poly(4-Vinylpyridine) (4-VP) and Polystyrene (PS) polymer thin films on silicon substrates were sputtered with Ar^+ ions under ultra-high vacuum (UHV) and then placed in either humid or dry conditions. The results show that wrinkling patterns are formed in 4-VP film after sputtering at 2 keV and consecutive humidification, but no wrinkling patterns are observed in PS under the same condition. The wrinkling amplitude of 4-VP films increases over time under humidity. Areas of lower ion flux have less order and higher amplitude wrinkling in 4-VP. Increasing film thickness increases wrinkle wavelength and decreases the order in the wrinkles. It is also found that the surface contact angle with water increased on both 4-VP and PS after ion beam sputtering, presumably due to increased roughness.



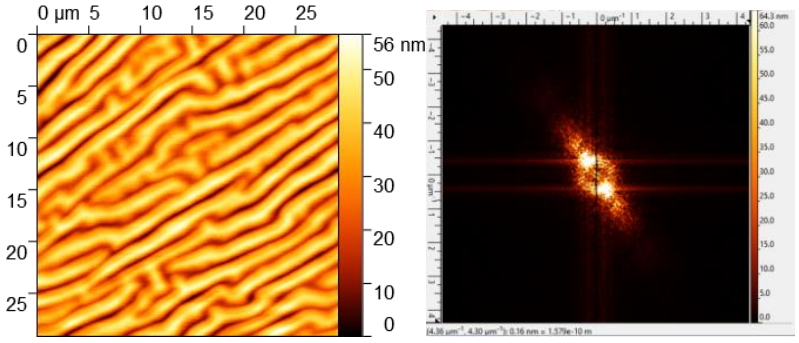
(a) 100nm Thick 4-VP Film (b) 250nm Thick 4-VP Film

Figure 1. AFM topographs showing evolution of sputtered 4-VP film wrinkling under humidity.

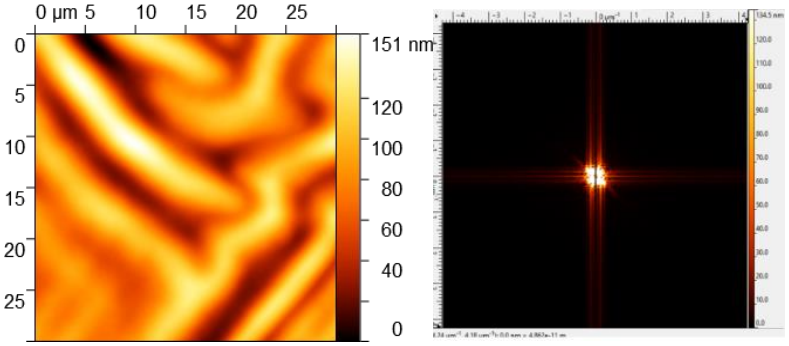
[1] R. Cuerno, and J.-S. Kim, 2020, J. 2020, Appl. Phys. 128, 180902

[2] Goyal M, et al, 2016, J. Appl. Phys. 119, 115303

Supplementary Information



(a) AFM image (left) and 2-D FFT image (right) from 100nm thick 4-VP film.



(b) AFM image (left) and 2-D FFT image (right) from 250nm thick 4-VP film.

Fig. 2 Comparison of AFM topographs and 2-D Fast Fourier Transform (FFT) from 4-VP films after day 7 under humidity

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