IRG-2: MAPLE of Polymer Films for Morphology Control

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Direct control of the crystalline morphology in polymer thin films is difficult to achieve and is recognized as a major technological challenge. The crystalline phase is often achieved *via* thermal annealing or melt-crystallization of pre-cast polymer films with an initial state of an entangled chain network. In contrast, physical vapor deposition is often utilized to control morphology in films of molecular systems. Achieving similar control of the crystalline morphology in polymer films represents a major challenge *via* PVD because their high molecular weights have previously precluded their direct and additive deposition with this approach. PCCM researchers recently addressed this problem by undertaking a study to demonstrate that Matrix Assisted Pulsed Laser Evaporation (MAPLE) can be suitably applied for the slow (~ nm/sec) deposition of polymers (e.g., polyethylene oxide (PEO)) to control morphology. This discovery sets the stage for the use of MAPLE is industrial processes for depositing thin polymer films.

Reference: Hyuncheol Jeong, Kimberly B. Shepard, Geoffrey E. Purdum, Yunlong Guo, Yueh-Lin Loo, Craig B. Arnold, Rodney D. Priestley, *Additive Growth and Crystallization of Polymer Films*, submitted (2015)

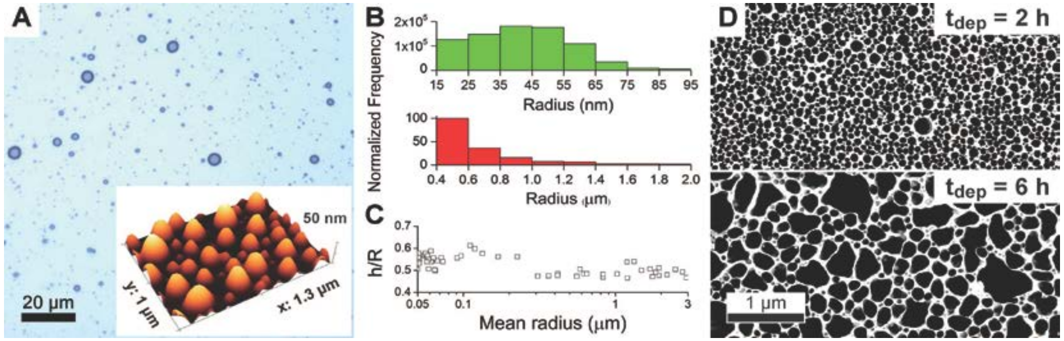

Fig. 1. MAPLE deposition of PEO on OTS-Si (hydrophobic) substrate at 25 °C. (**A**) Optical microscopy (main) and AFM height image (inset) of a MAPLE-deposited PEO film (droplets) on OTS-Si substrate. (**B**) Histogram plots showing the normalized size distribution of PEO droplets in an OTS-Si sample obtained with t_{dep} = 2 h. AFM and optical microscopy images were used to investigate the number of nano-droplets (upper panel) and micro-droplets (lower panel), respectively. (**C**) Plots showing the h/R ratio of 57 PEO droplets investigated. (**D**) AFM phase images of PEO films formed with t_{dep} = 2 h (upper panel) and 6 h (lower panel). Both images have the same size.

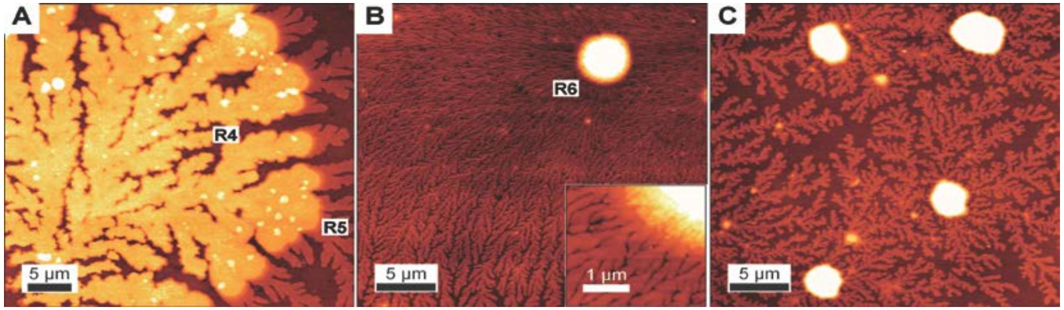

Fig. 2. MAPLE deposition of PEO on AR-Si (hydrophilic) substrate with T_{sub} control. (A - B) Samples were made with two sequential MAPLE depositions: the MAPLE 1st was conducted with t_{dep} = 2 h and T_{sub} = 25 °C, followed by MAPLE 2nd with t_{dep} = 4 h and T_{sub} = 50 °C. The samples were cooled to room temperature after deposition. (**A**) AFM height image showing the morphology of a type 1 crystalline island that formed with a primary nucleation in MAPLE 1st step. (**B**) AFM height image showing the morphology of a type 2 crystalline island that formed with a primary nucleation in cooling step. The inset image magnifies the region R6. (**C**) AFM height image showing the morphology of a sample made with t_{dep} = 2 h at 50 °C followed by a cooling to room temperature.