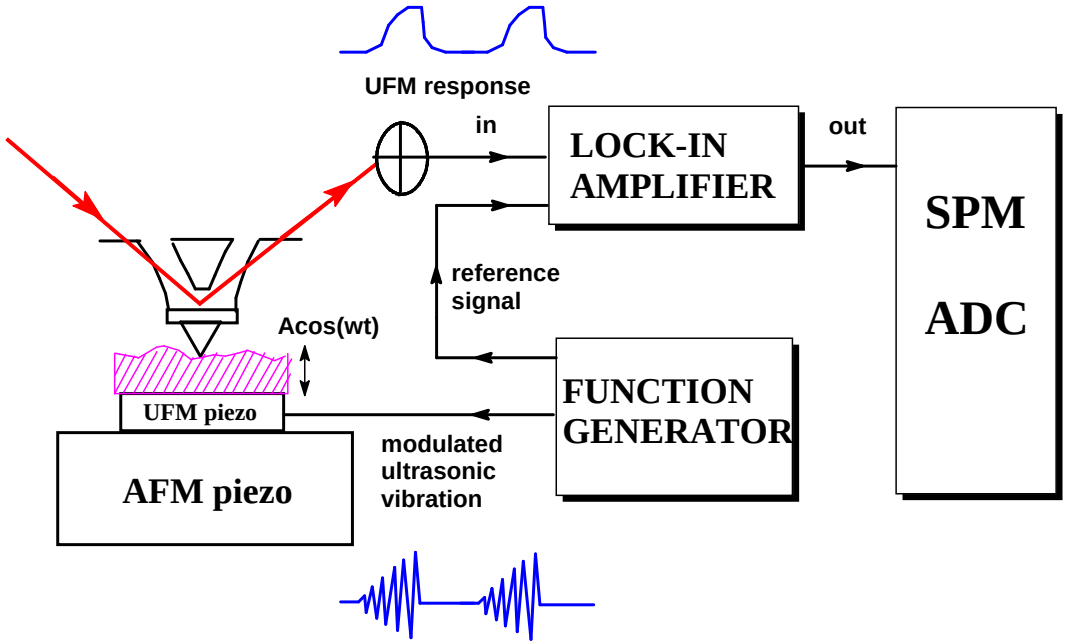
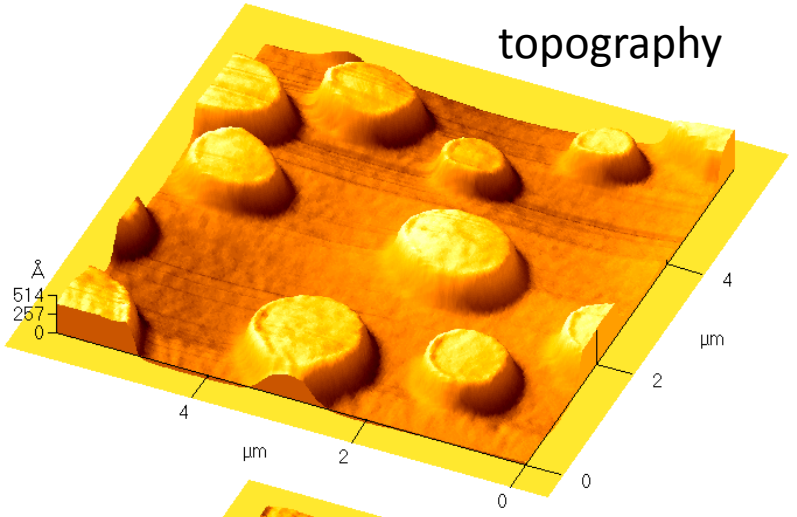
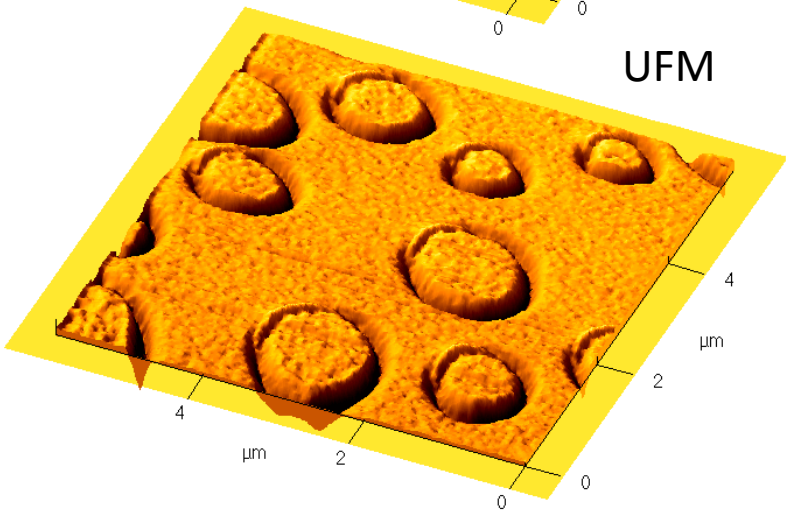
The Ultrasonic Force Microscopy (UFM) technique

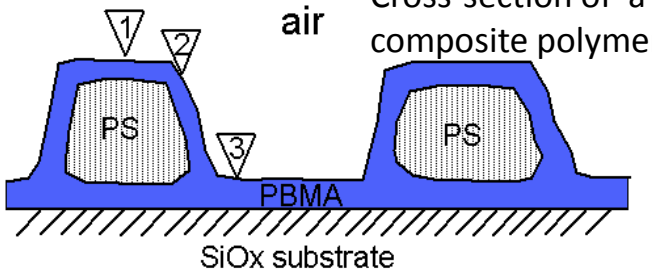
UFM non-destructive SPM mode, which brings additional information usually inaccessible in conventional SPM modes. The basic principle of UFM consists in application of high frequency waves (above the resonance frequency of the cantilever used) with the help of an additional piezo-transducer in a vertical direction (normal to the surface of the sample and to the direction of scanning). Simultaneously, a lower frequency modulation (kHz range) of these ultrasonic waves is applied, and then detected as the cantilever response signal with a lock-in amplifier. Application of ultrasonic frequency allows effective stiffening of the AFM cantilever, and its non-destructive (elastic) indentation into material under study. UFM is especially suitable for the study of heterogeneous semi-crystalline polymers as a sensitive tool to nano-scale variation of density and Young's modulus inside the sample near the surface.



Yamanaka et al. "Ultrasonic Force Microscopy for nanometer resolution subsurface imaging", APL, 64 (2), pp. 178-180 (1994)



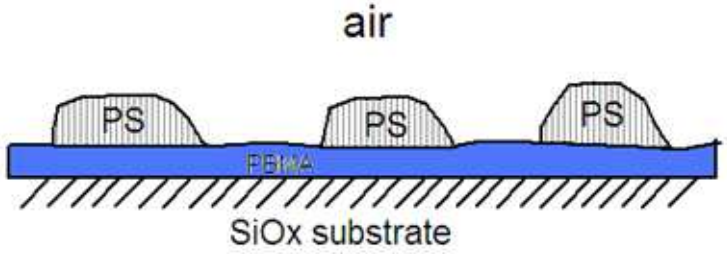




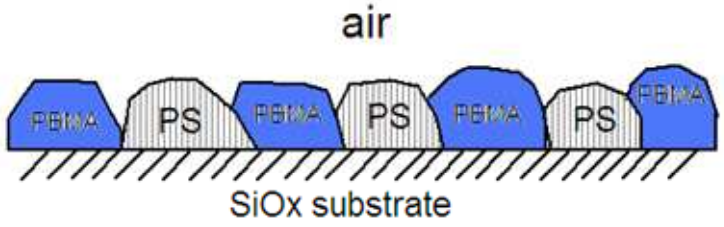
Cross-section of a composite polymer film

PS-PBMA adsorbed films on silicon

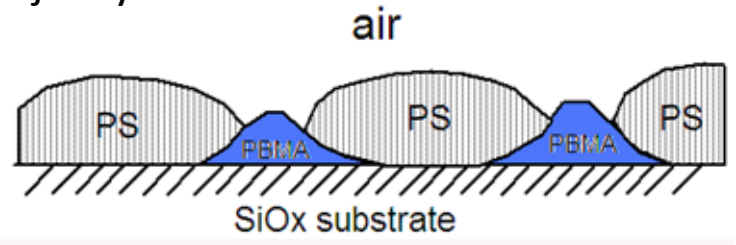
Majority of PBMA



PBMA:PS =1:1



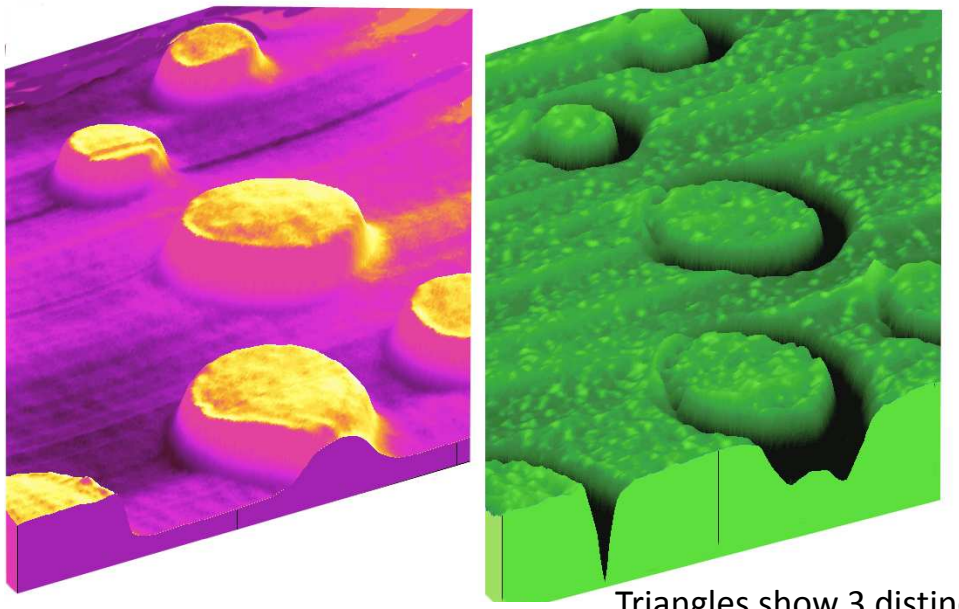
Majority of PS



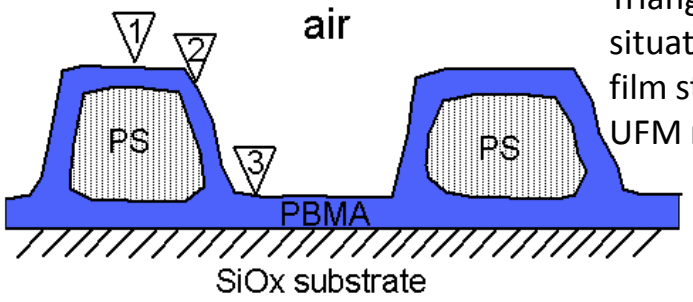
Phase separation in polymer films absorbed from binary polymer solutions is controlled by thermodynamics of polymer-polymer, polymer-solvent and polymer substrate interactions

V.N. Bliznyuk, Y.S. Lipatov, N. Ozdemir, T.T. Todosijchuk, V.N. Chornaya, S. Singamaneni, ***Langmuir,*** 2007, **23,** 12973

Topography **UFM**



Triangles show 3 distinct situations for polymer film stiffness mapped in UFM mode



PS:PBMA= 1:3 mixed sample fabricated by solution casting shows characteristic structure of flat-top domains, which are formed due to self-organization of immiscible polymer components confined within a thin polymer solution meniscus during solid film formation. The structure is due minimization of both cohesive energy of polymer film-substrate interface and surface free energy of the final polymer film during solution casting process.