

Surface and Interface Microstructures of PVDF-based Materials; Project 3

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Objective: To investigate the differences between film/air microstructure and film/substrate microstructure of PVDF-based materials.

- Information obtained should provide a better understanding on the surface wettability, paintability, bondability, washability and weatherability, and substrate/film adhesion of PVDF-based materials.

Tapping Mode AFM

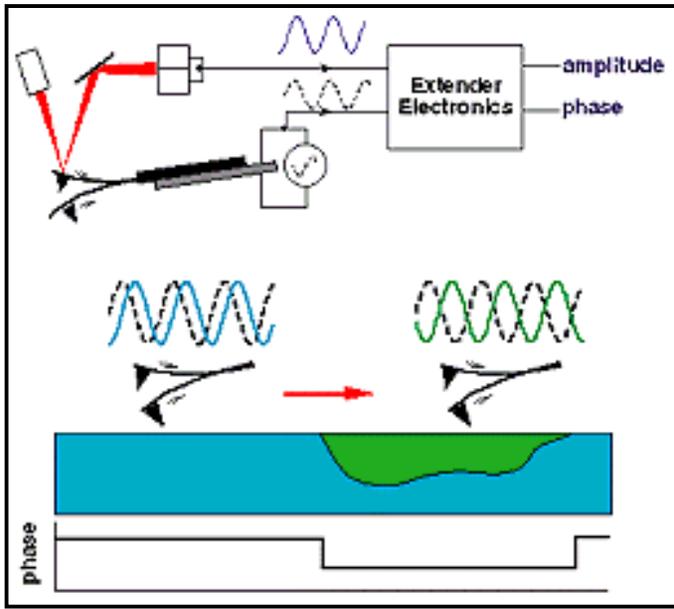
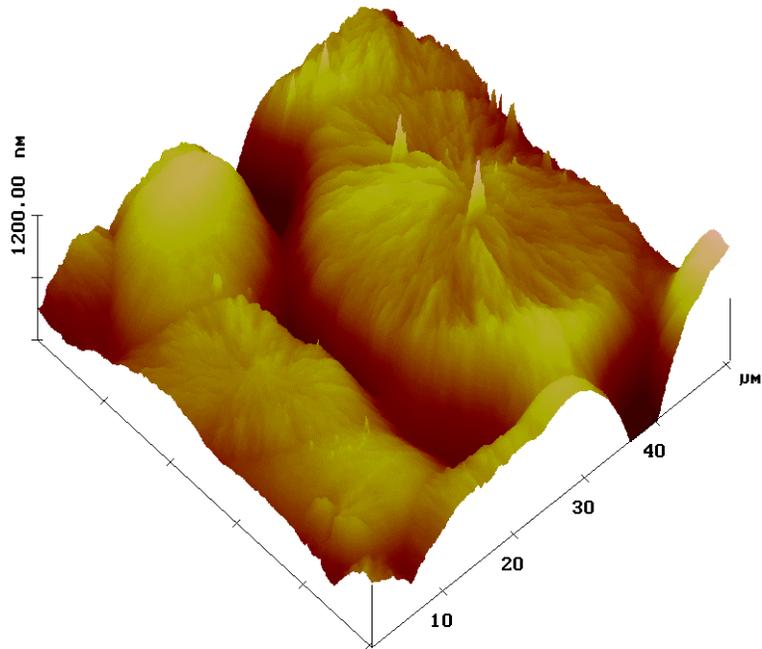


Illustration courtesy of Digital Instruments

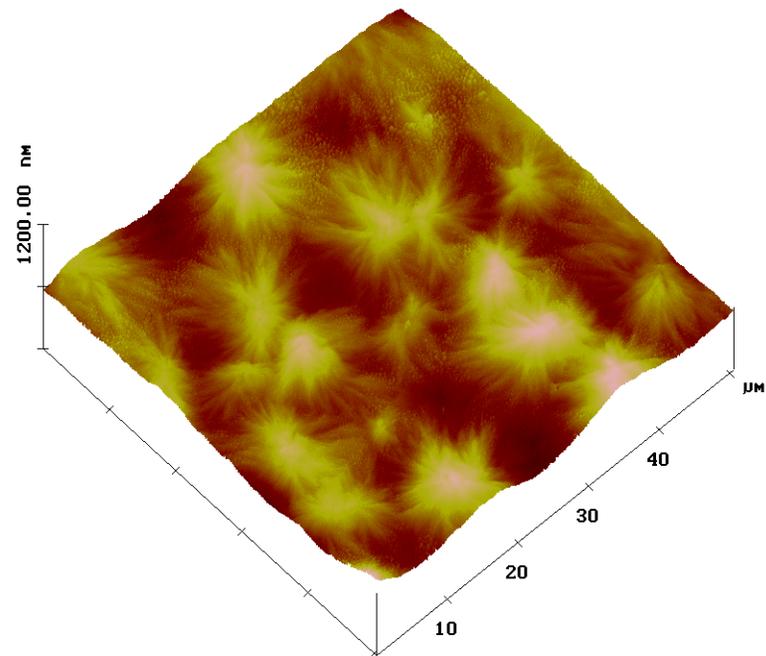
- The cantilever probe is oscillated at its resonance frequency such that it makes contact (taps) with the sample only for a short duration in each oscillation cycle.
- As the tip approaches the sample, the tip-sample interactions change the amplitude, the resonance frequency, and the phase angle of the oscillating probe.
- Monitoring the amplitude of the oscillation provides topographic images.
- Monitoring changes in phase of the oscillating probe can often provide useful information on the properties of the imaged areas, because phase change is a function of material properties of the sample and the tip and their interactions.

PMMA-CO-PEA/PVDF: 30/70 (by Mass)

Film/Air Interface



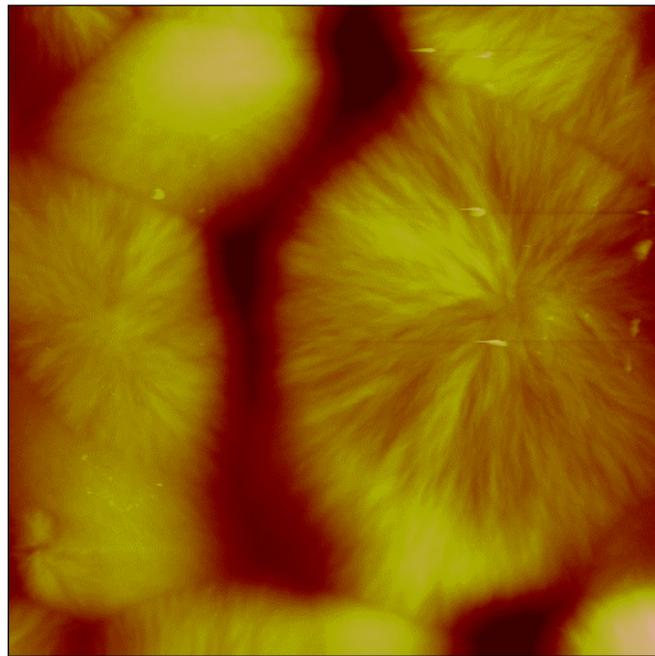
Film/Glass Interface



3-D

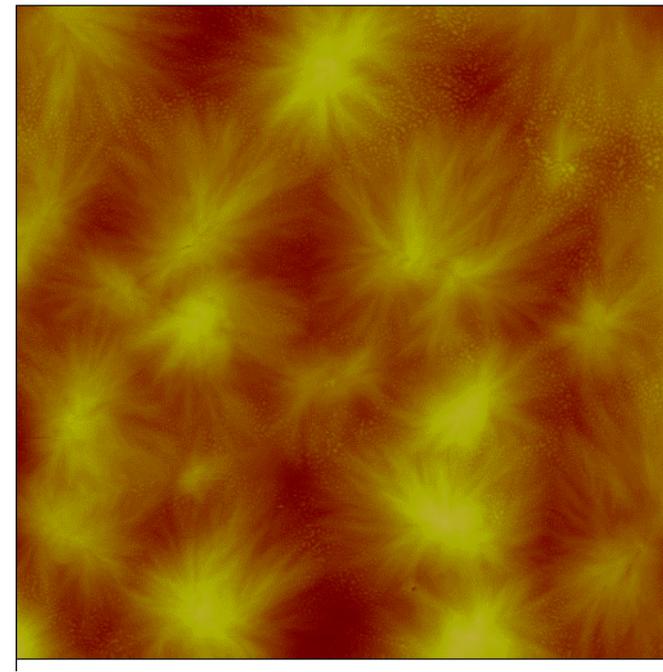
PMMA-CO-PEA/PVDF: 30/70 (by Mass)

Film/Air Interface



0 50.0 μm
Data type Z range
Height 1200 nm

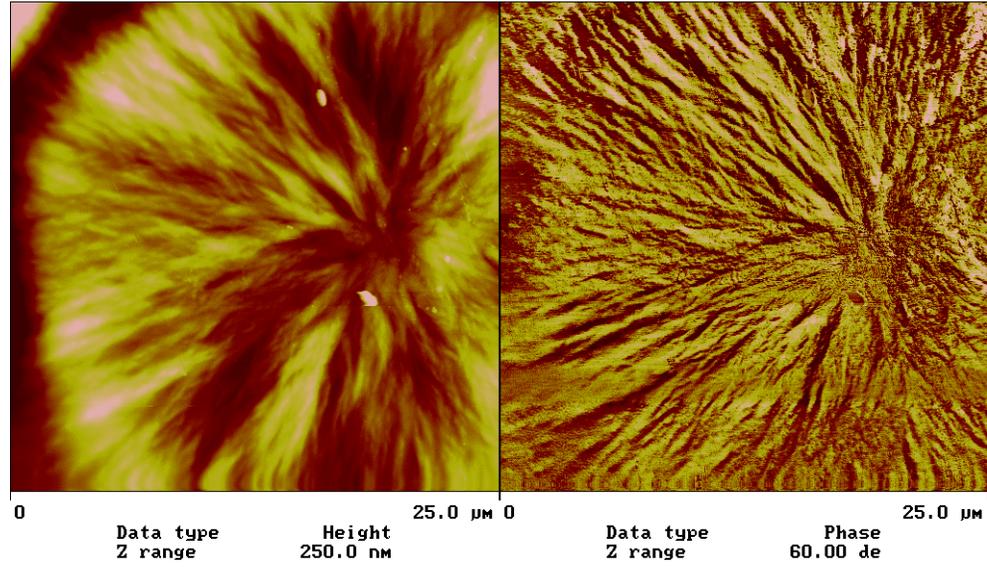
Film/Glass Interface



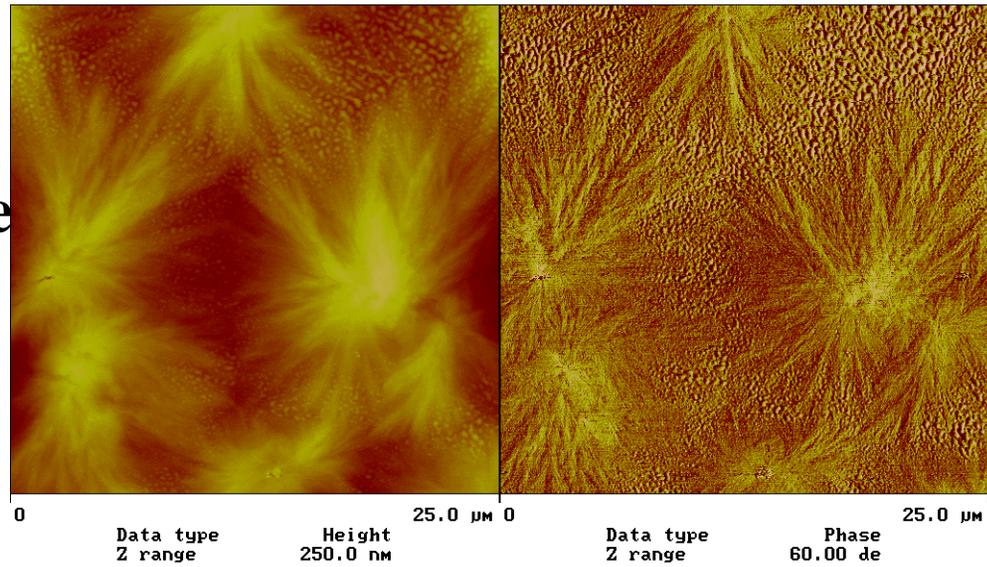
0 50.0 μm
Data type Z range
Height 500.0 nm

PMMA-CO-PEA/PVDF: 30/70 (by Mass)

Film/Air Interface

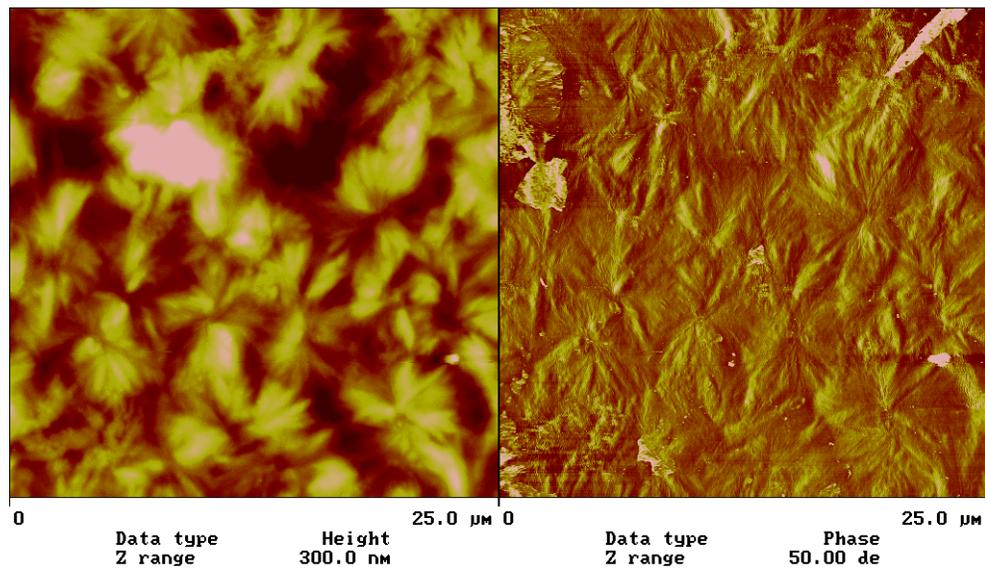


Film/Glass Interface

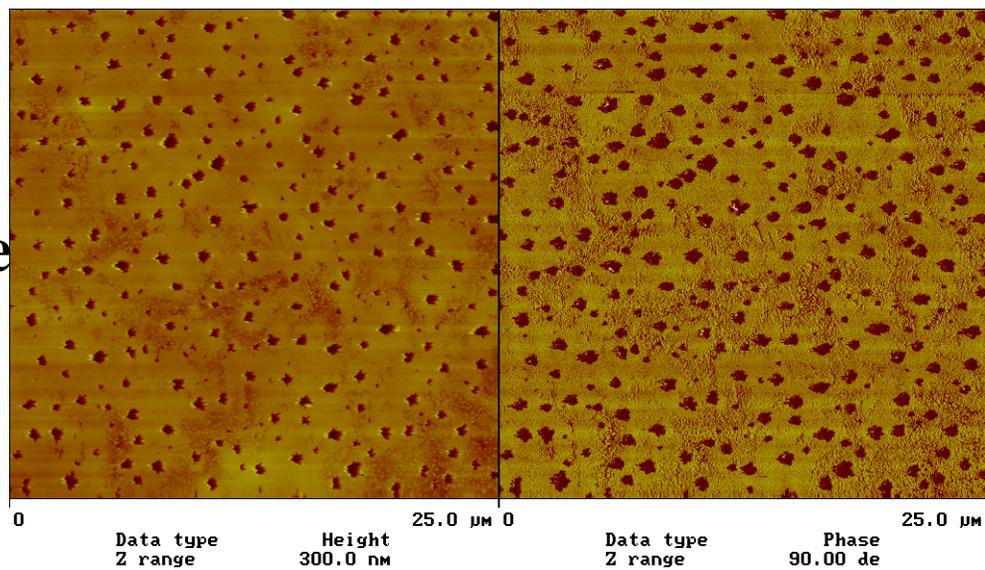


PMMA-CO-PEA/PVDF: 50/50 (by Mass)

Film/Air Interface



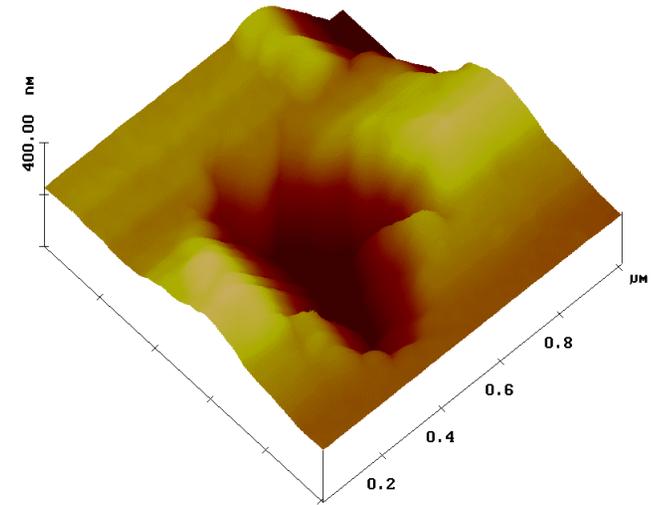
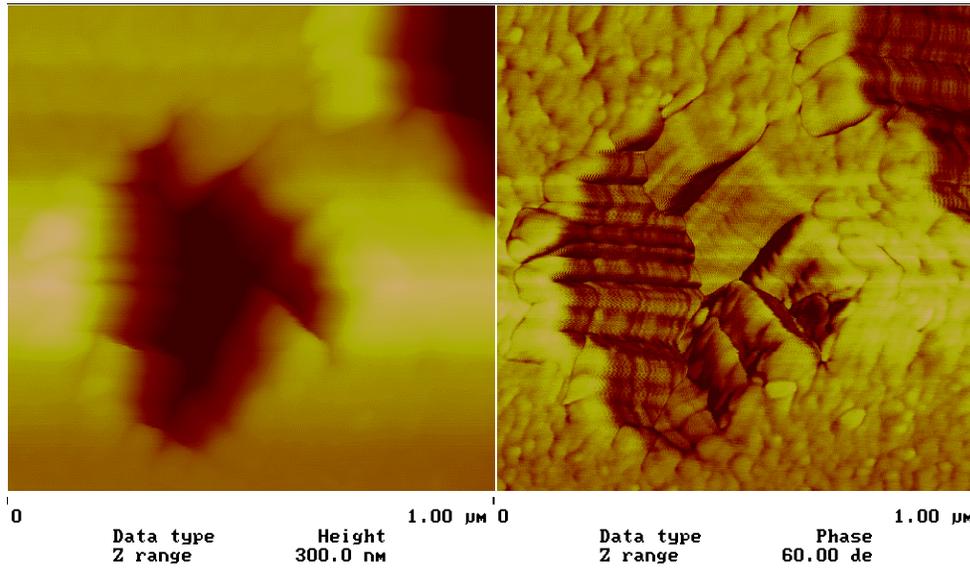
Film/Glass Interface



PMMA-CO-PEA/PVDF: 50/50 (by Mass)

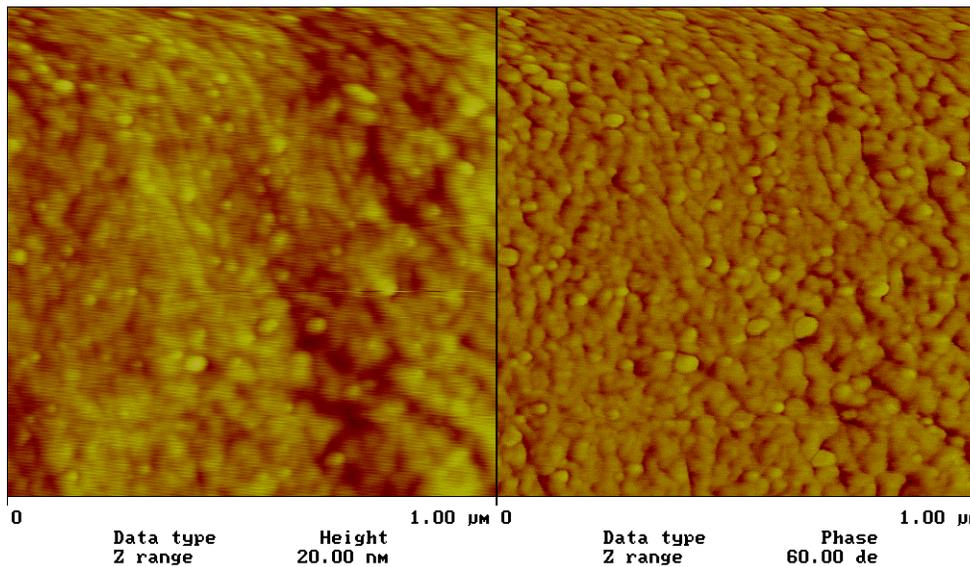
Film/Glass Interface

Hole



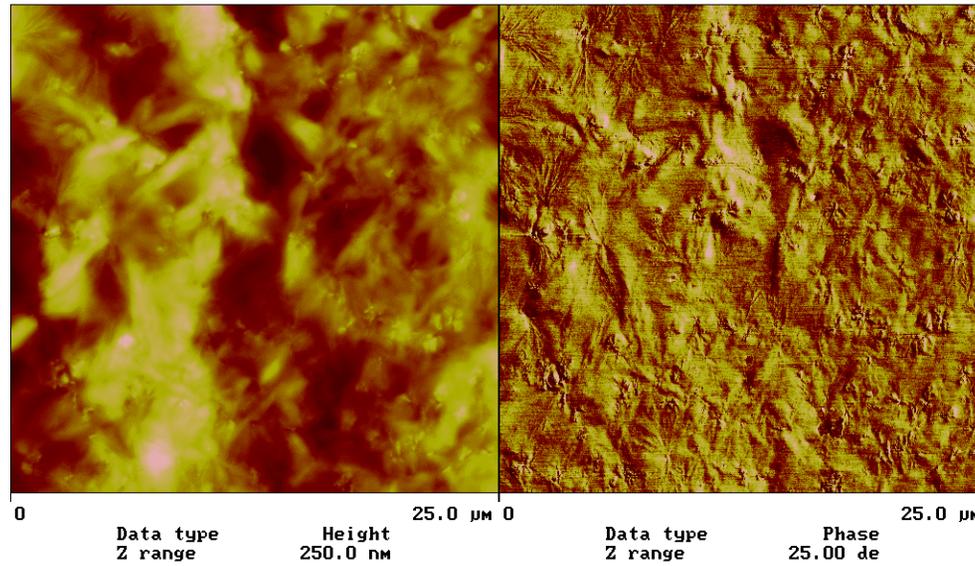
3-D of the Hole

Smooth Area

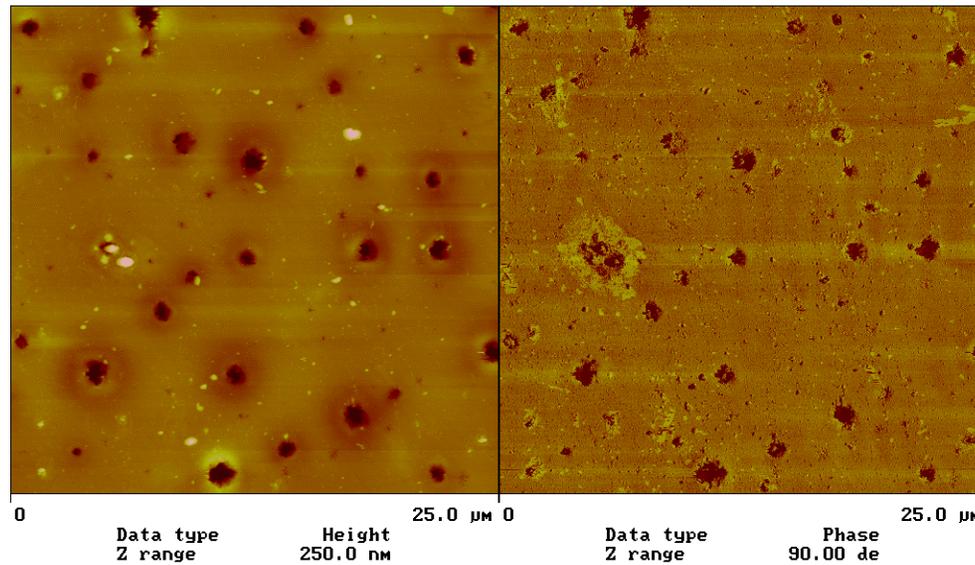


PMMA-CO-PEA/PVDF: 70/30 (by Mass)

Film/Air Interface

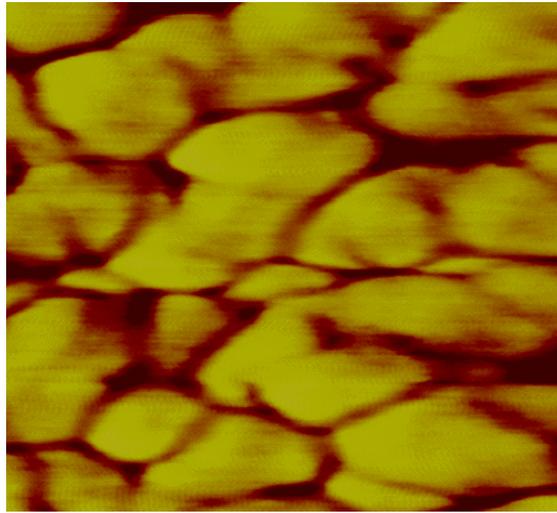


Film/Glass Interface

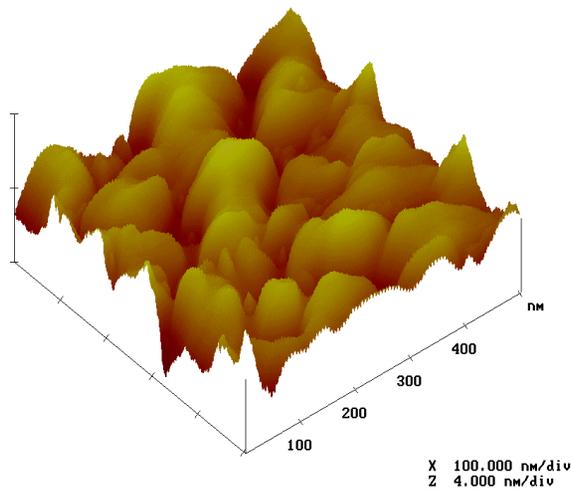


Microstructure of Amine-Cured Epoxy Film (300 μm)

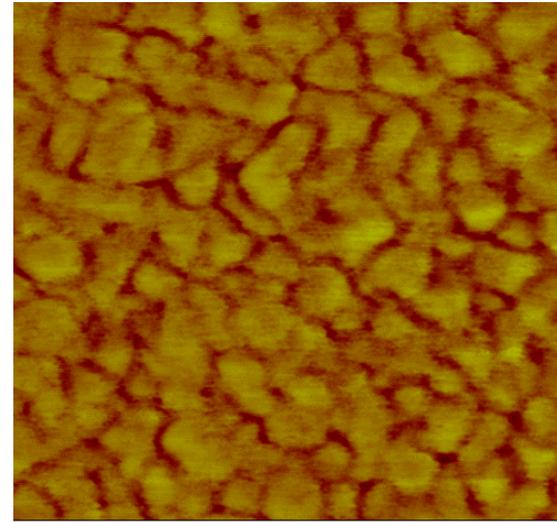
Film/Substrate Interface



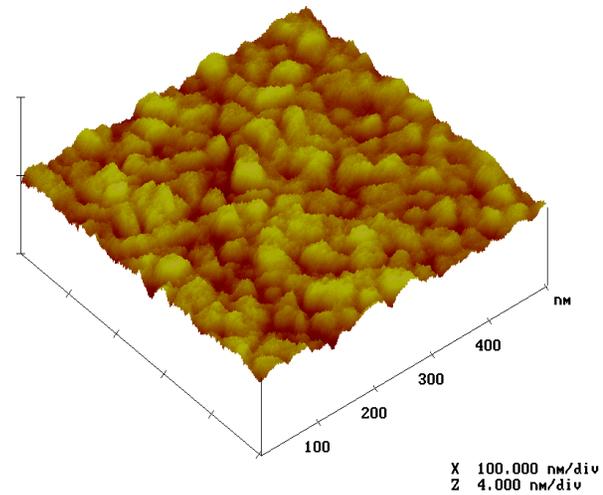
500 nm \times 500 nm



Film/Air Interface



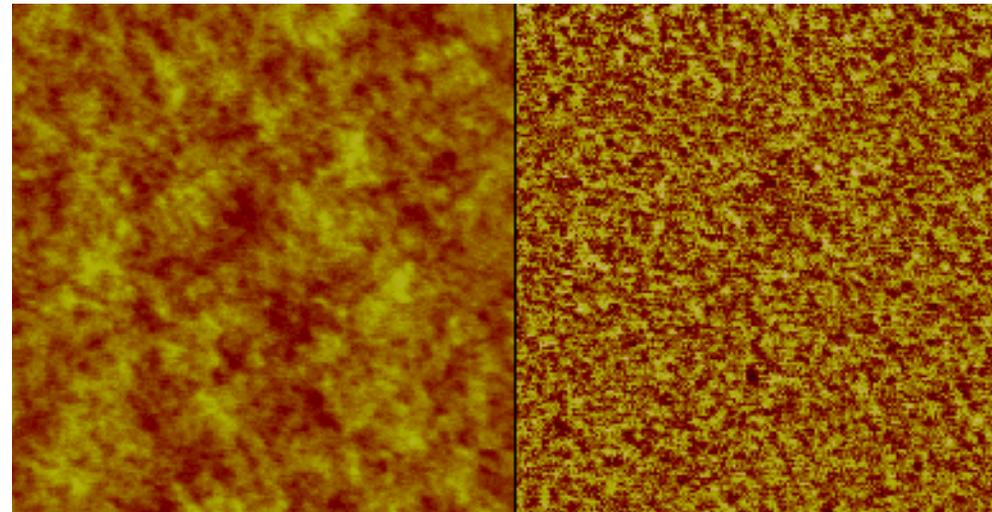
500 nm \times 500 nm



Microstructure of Acrylic-Melamine Coating

5 μm thick

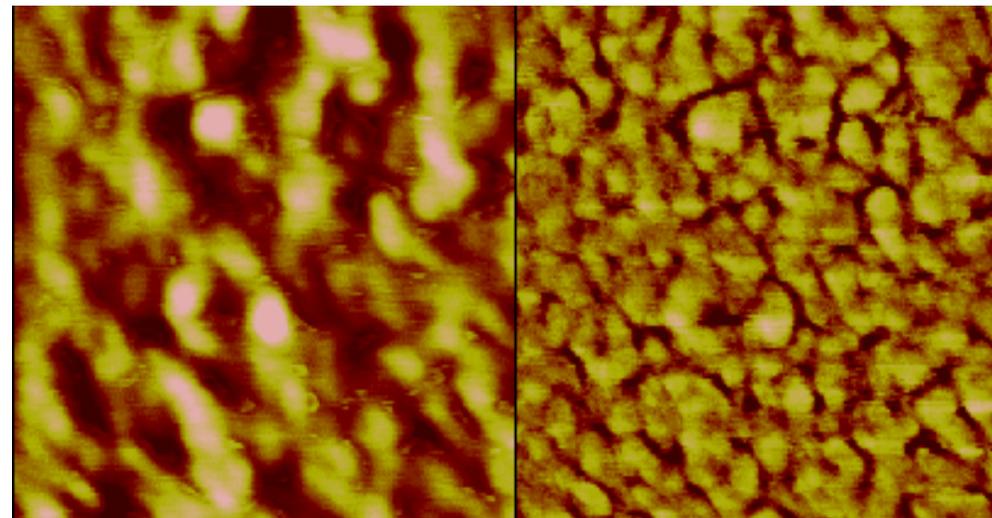
Film/Air



Data type: Z range
Height: 5.000 nm
5000 nm

Data type: Z range
Phase: 10.00 deg
5000 nm

Film/Silicon



Data type: Z range
Height: 5.000 nm
500 nm

Data type: Z range
Phase: 50.00 deg
500 nm

XPS Analysis

TABLE 1

COMPOSITION OF THE SURFACE THE AIRSIDE AND GLASS SIDE OF MODIFIED PVDF-TYPE COATING
AS DETERMINED BY PHOTOELECTRON SPECTROSCOPY

RESIN TYPE	SUBMITTER SAMPLE DESCRP.	SUBMITTER SAMPLE #	LIMS #	VG FILE #	ATOM PERCENT								
					C	O	F	SI	N	S	NA	CA	
	AIRSIDE, 70/30	A1	SCL-01-025-1	0102501	63.2	25.4	7.4	0.6	0.5	0.29	2.58		
	GLASS SIDE, 70/30	A2	SCL-01-025-2	0102502	65.6	24.2	6.3	1.0	0.5	0.22	2.11	0.19	
PMMA-CO-PEA/PVDF	? Air side, 50/50	B1	SCL-01-025-3	0102503	69.2	23.7	6.3	0.6	0.3				
	? Glass side, 50/50	B2	SCL-01-025-4	0102504	63.8	23.5	11.5	0.1	0.3		0.73	0.00	
	? Air side, 30/70	C1	SCL-01-025-5	0102505	65.3	25.4	8.3	0.6	0.3	0.16			
	? Glass side, 30/70	C2	SCL-01-025-6	0102506	60.8	22.8	15.2	0.2	0.7	0.33			
PVDF	AIRSIDE	D1	SCL-01-025-7	0102507	43.4	1.7	54.3			0.06	0.46		
	GLASS SIDE	D2	SCL-01-025-8	0102508	46.6	3.7	48.0	0.3	0.2	0.11	1.08		
FILE://2001/01025_DN.XIS													

Conclusions

- AFM results show differences in the microstructures between the film/air and the film/substrate interfaces of PVDF/polymer blends; in agreement with observations for other coatings.
- The result has great implications on film/substrate adhesion and secondary processes on the surfaces of PVDF-based materials.

Future work

1. Verify XPS data.
2. Wettability and surface free energies of film-air and film-substrate surfaces.
3. FTIR-ATR of film-air and film-substrate surfaces.
4. Photodegradation of film-air and film-substrate surfaces, measured by AFM, FTIR-ATR, and XPS.