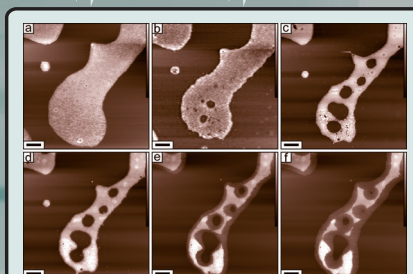


SFM in Controlled Vapour Environment as a Tool to Observe Induced Morphology Changes of Polymer Nanostructures at Interfaces in Real Time

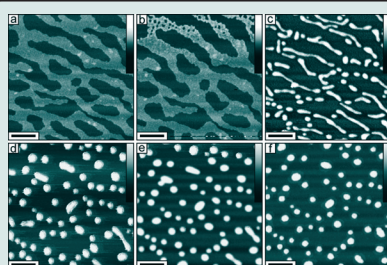
Marat O. Gallyamov,^[a] Krystyna Albrecht,^[b] Ahmed Mourran,^[b] Alexei R. Khokhlov,^[a] Martin Möller^[b]

^[a] Faculty of Physics, M. V. Lomonosov Moscow State University, Leninskie Gory, 119992 Moscow, Russia

^[b] DWI an der RWTH Aachen e.V., Pauwelsstrasse 8, 52056 Aachen, Germany

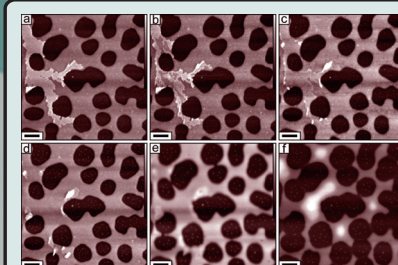


PS₁₁₅-b-PEO₂₁₅ ultrathin film exposed to ethanol and water vapours; a: initial image; b,c: images obtained after 10 min (b) and 1 h (c) exposure to ethanol vapour; d: in dry nitrogen; e,f: images recorded after 6 h (e) and 12 h (f) exposure to water vapour. Bar size: 250 nm, height scales: 10 nm (a), 4 nm (b), 17 nm (c,e,f), 13 nm (d)

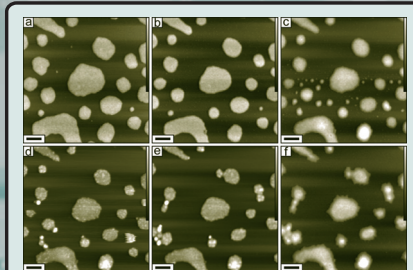


PS₁₁₅-b-PEO₂₁₅ ultrathin film exposed to ethanol vapour; a: initial image; b-e: images obtained after 3 min (b), 8 min (c), 17 min (d), and 25 min (e) exposure to ethanol vapour; f: in dry nitrogen.

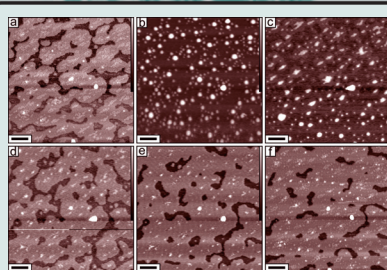
Bar size: 250 nm, height scale: 10 nm



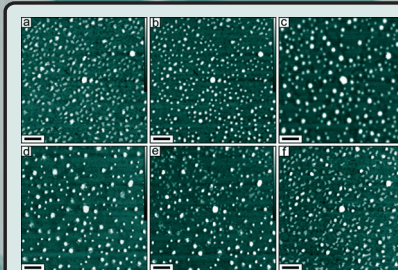
PS₁₁₅-b-PEO₂₁₅ ultrathin film exposed to vapours; a: initial image; b,c: images obtained after 1 h (b) and 2.5 h (c) exposure to water vapour; d: in dry nitrogen (after 4 h exposure to water vapour); e: image recorded after 36 h exposure to ethanol vapour (hum.); f: after 15 min exposure to chloroform vapour. Bar size: 600 nm, height scales: 15 nm (a-d), 30 nm (e,f)



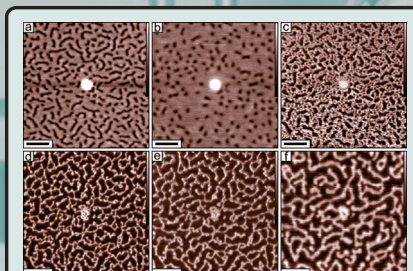
PS₁₁₅-b-PEO₂₁₅ ultrathin film exposed to vapours; a: initial image; b,c: images obtained in nitrogen after 2 h exposure to ethanol (hum.) (b), and 10 min to chloroform (c) vapours; d-f: images recorded after 1 h (d), 4 h (e), and 20 h (f) exposure to water vapour. Bar size: 300 nm, height scales: 7 nm (a,b), 10 nm (c), 17 nm (d,e), 12 nm (f)



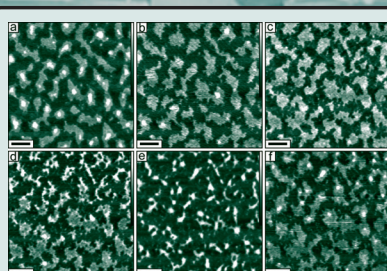
PS₉₅-b-PEO₂₆₉ ultrathin film exposed to ethanol vapour and nitrogen flow; a: initial image; b: image obtained after 7 min exposure to ethanol vapour; c-f: images recorded in nitrogen flow: 7 min (c, after 30 min in ethanol), 15 min (d), 1 h (e), and 4 h (f) exposure to nitrogen atmosphere. Bar size: 200 nm, height scales: 2 nm (a,f), 8 nm (b), 4 nm (c), 3 nm (d), 2.5 nm (e)



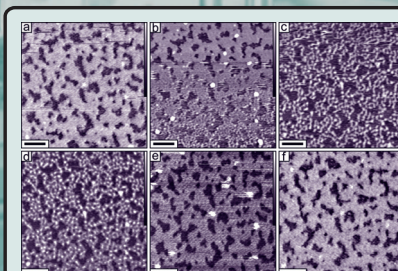
PS₉₅-b-PEO₂₇₅ ultrathin film exposed to ethanol and water vapours; a: initial image; b, c: images obtained after 5 (b) and 30 min (c) exposure to ethanol vapour; d: in dry nitrogen (after 1 h exposure); e: image after 5 min exposure to water vapour; f: in dry nitrogen (after 30 min exposure to water). Bar size: 200 nm, height scales: 2 nm (a,f), 3 nm (b,d,e), 7.5 nm (c)



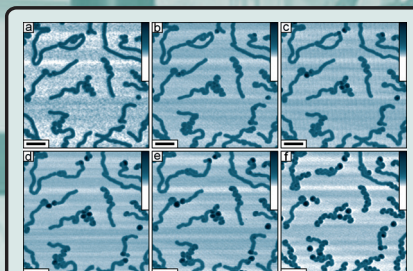
PS₃₃₀-b-P4VP₃₀ ultrathin film exposed to vapours; a,b: in THF vapour for 20 min (a) and 2 h (b); c,d: images obtained after beginning (c) and 30 min exposure (d) to ethanol vapour; e: in nitrogen; f: image recorded after 20 h exposure to water vapour. Bar size: 250 nm, height scales: 5 nm (a-c), 9 nm (d), 8 nm (e), 6 nm (f)



P2VP₉₀-b-PEO₁₆₈₀ ultrathin film exposed to ethanol and water vapours; a: initial image; b: image obtained after 15 min exposure to water vapour; c: in dry nitrogen; d,e: images recorded after 7 min (d) and 15 min (e) exposure to ethanol vapour; f: after 15 min exposure to water vapour. Bar size: 150 nm, height scales: 3 nm (a), 1.6 nm (b,c), 2.5 nm (c,f), 3.5 nm (e)

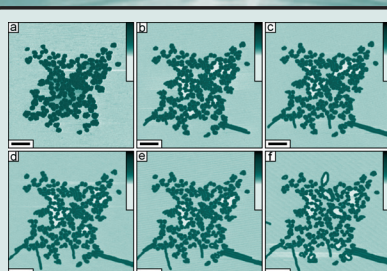


P2VP₉₀-b-PEO₃₁₀ ultrathin film exposed to ethanol and water vapours; a: initial image; b: image obtained after starting exposure to ethanol vapour; c: in nitrogen (after 15 min exposure to ethanol); d,e: images recorded after starting (d) and 15 min (e) exposure to water vapour; f: in nitrogen (after 45 min exposure to water). Bar size: 200 nm, height scales: 1 - 4.5 nm



PE₂₀-b-PTFE₁₁ structures exposed to hexafluoroxylene vapour; a: initial image as deposited from solution in decaline; b-f: images obtained after 2.5 h (b), 5 h (c), 7.5 h (d), 10 h (e), and 20 h (f) exposure to hexafluoroxylene (HFX) vapour.

Bar size: 250 nm, height scale: 10 nm



PE₂₀-b-PTFE₁₁ structures exposed to perfluorodecaline vapour; a: initial image as deposited from solution in hexafluoroxylene (HFX); b-f: images obtained after 2.5 h (b), 5 h (c), 7.5 h (d), 10 h (e), and 20 h (f) exposure to perfluorodecaline vapour.

Bar size: 350 nm, height scale: 10 nm

Morphology conversions of adsorbed polymer nanostructures can be stimulated by an exposure to different vapours [1-3]. The controlled rate of such transformations is sufficiently slow to allow the real-time following by *in situ* scanning force microscopy (SFM). Here we present real-time SFM-observations of vapour-induced structural transformations of ultrathin block-copolymer films on a mica substrate.

References:

- [1] Y. Xuan, et al. // *Macromolecules* 37 (2004) 7301.
- [2] A. Mourran, et al. // *Langmuir* 21 (2005), 2308.
- [3] M. Gallyamov et al. // *J. Microsc.*, 215 (2004) 245.

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