Templated Self-Assembly of Block Copolymer Thin Films

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Ed Kramer, Rachel Segalman

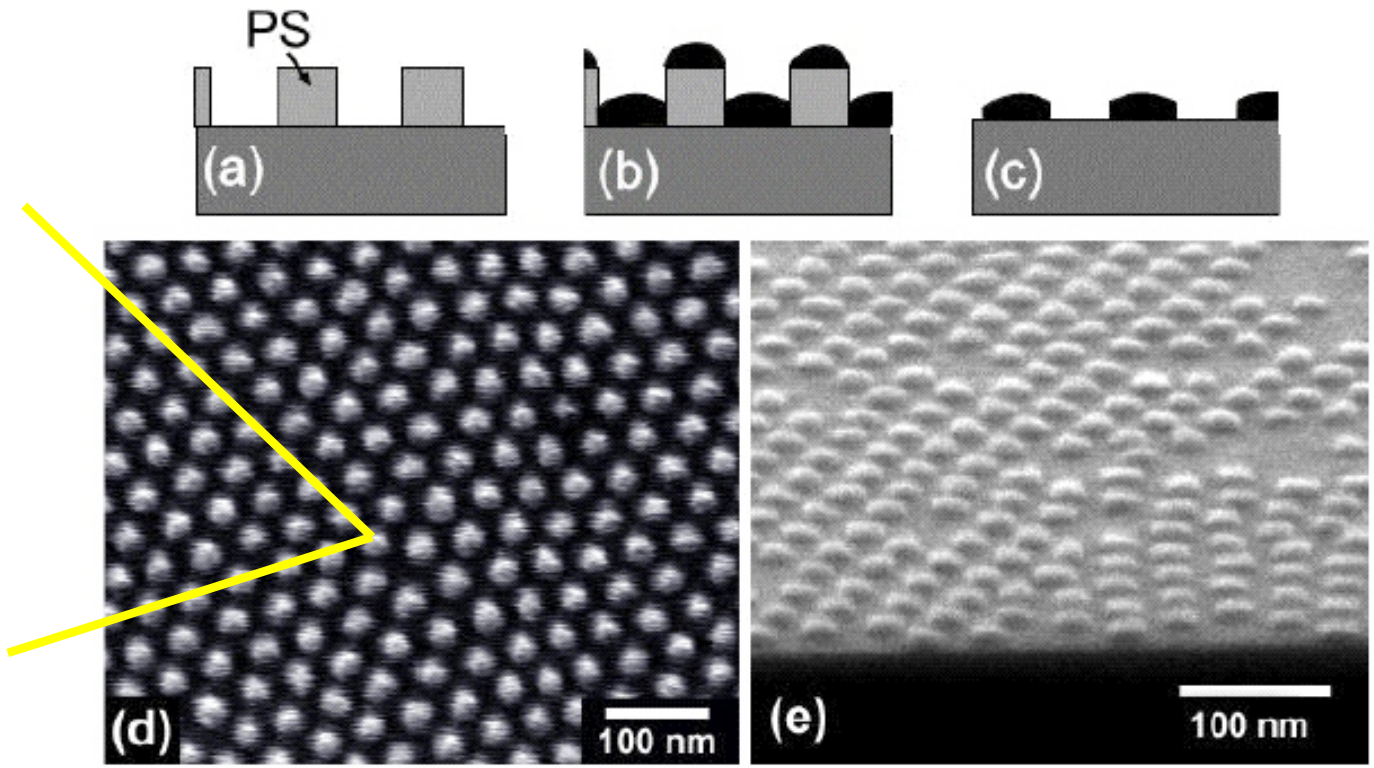
Two Dimensional Self Assembly

- Why? Nanopatterning of surfaces

  Extend limits of optical lithography

  Potentially cheap

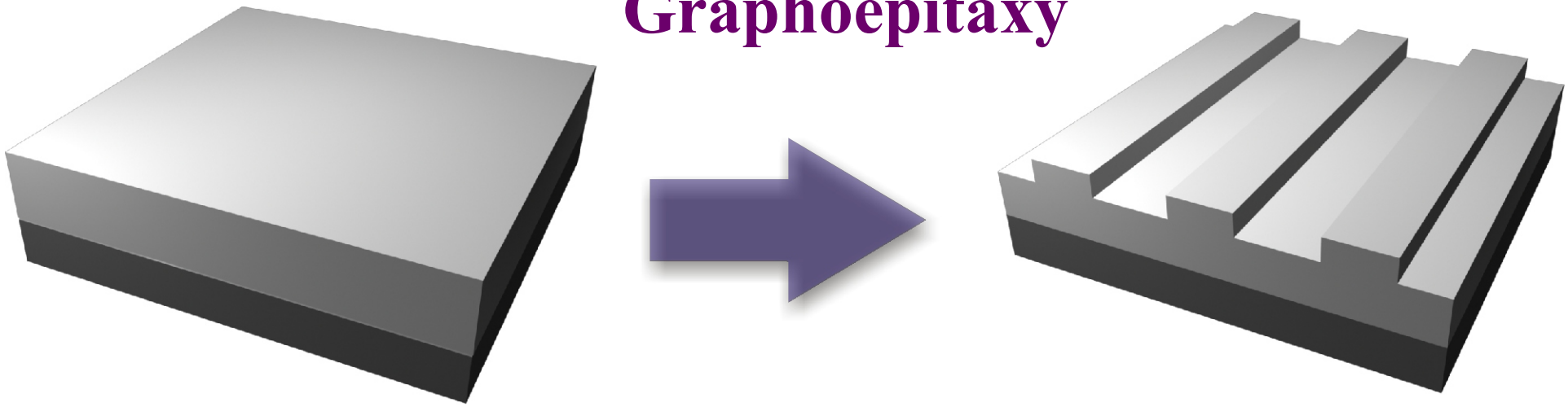
- Example: High density magnetic dot arrays



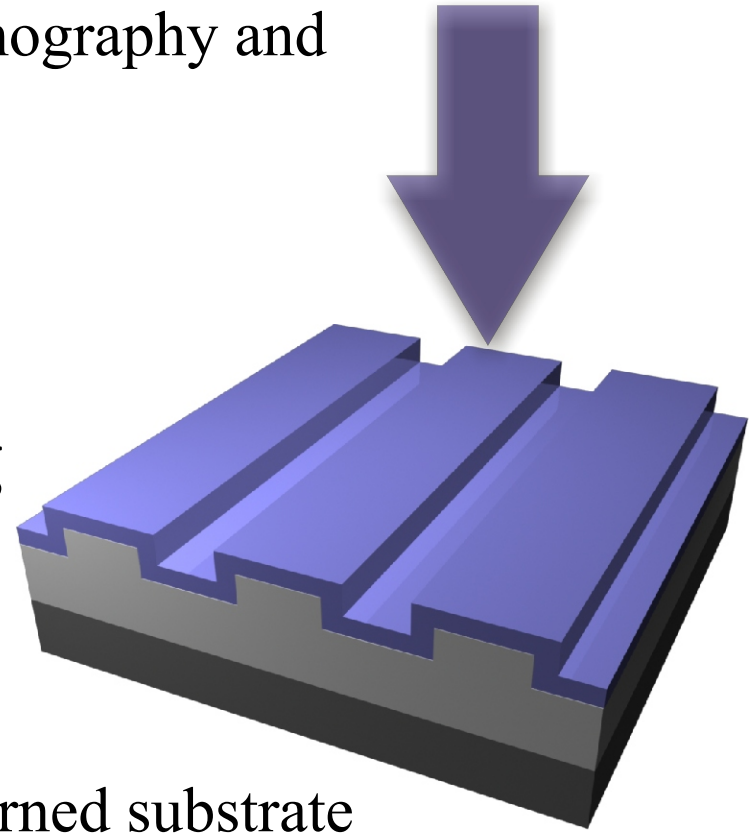
Chuck Black,
Craig Hawker,
Tom Russell, …

Topographical Confinement

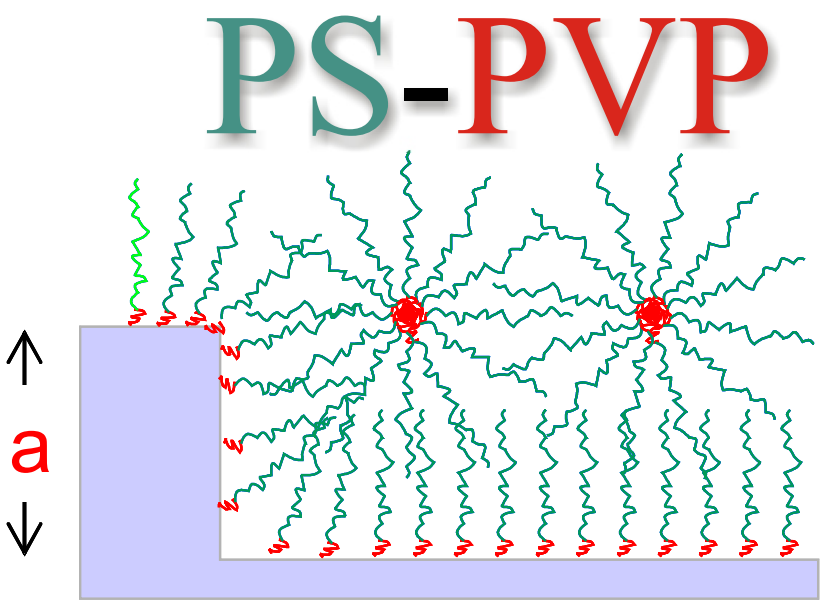
Graphoepitaxy



Laterally pattern substrate via standard photolithography and chemical etching of SiO_2

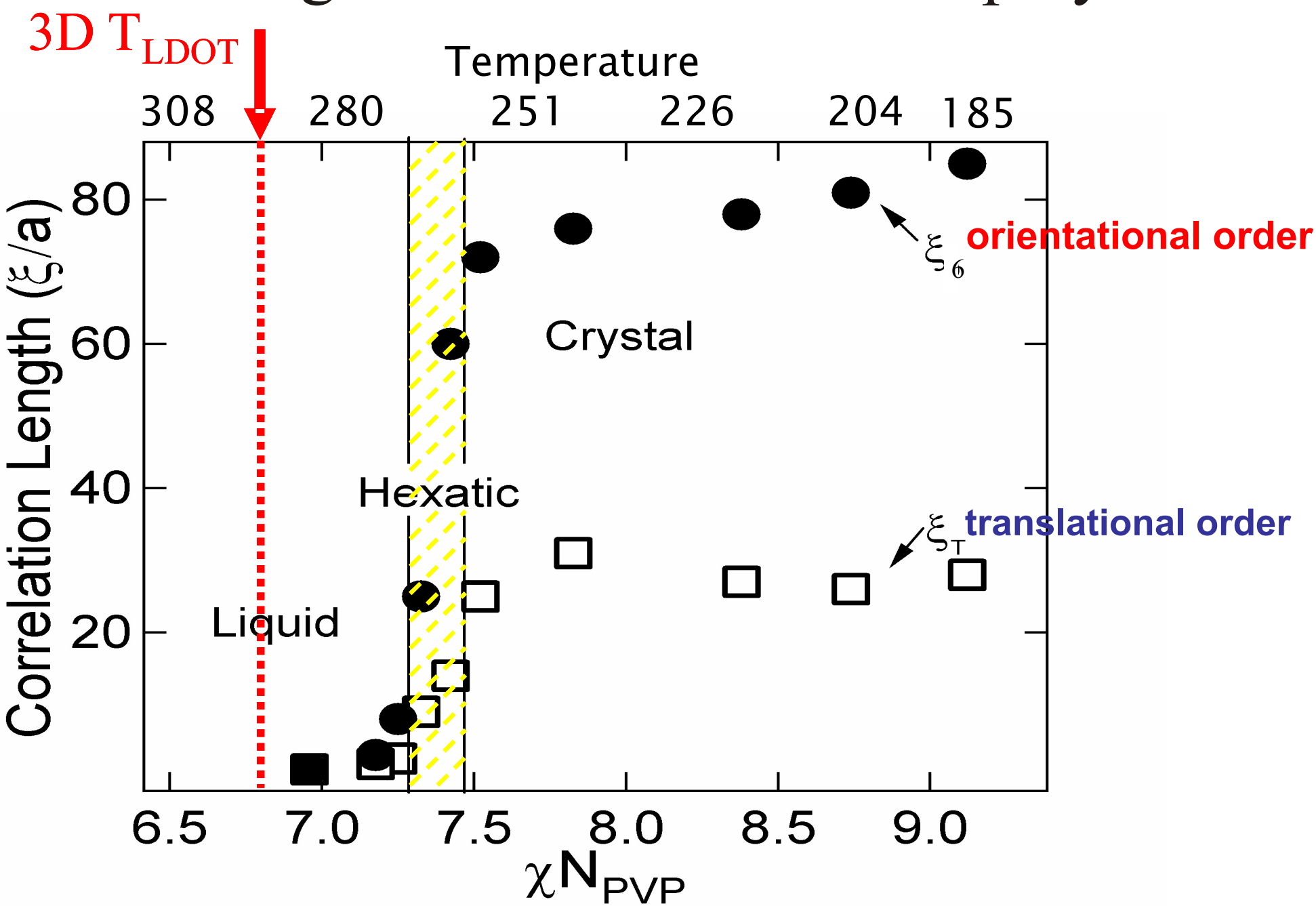


Annealing



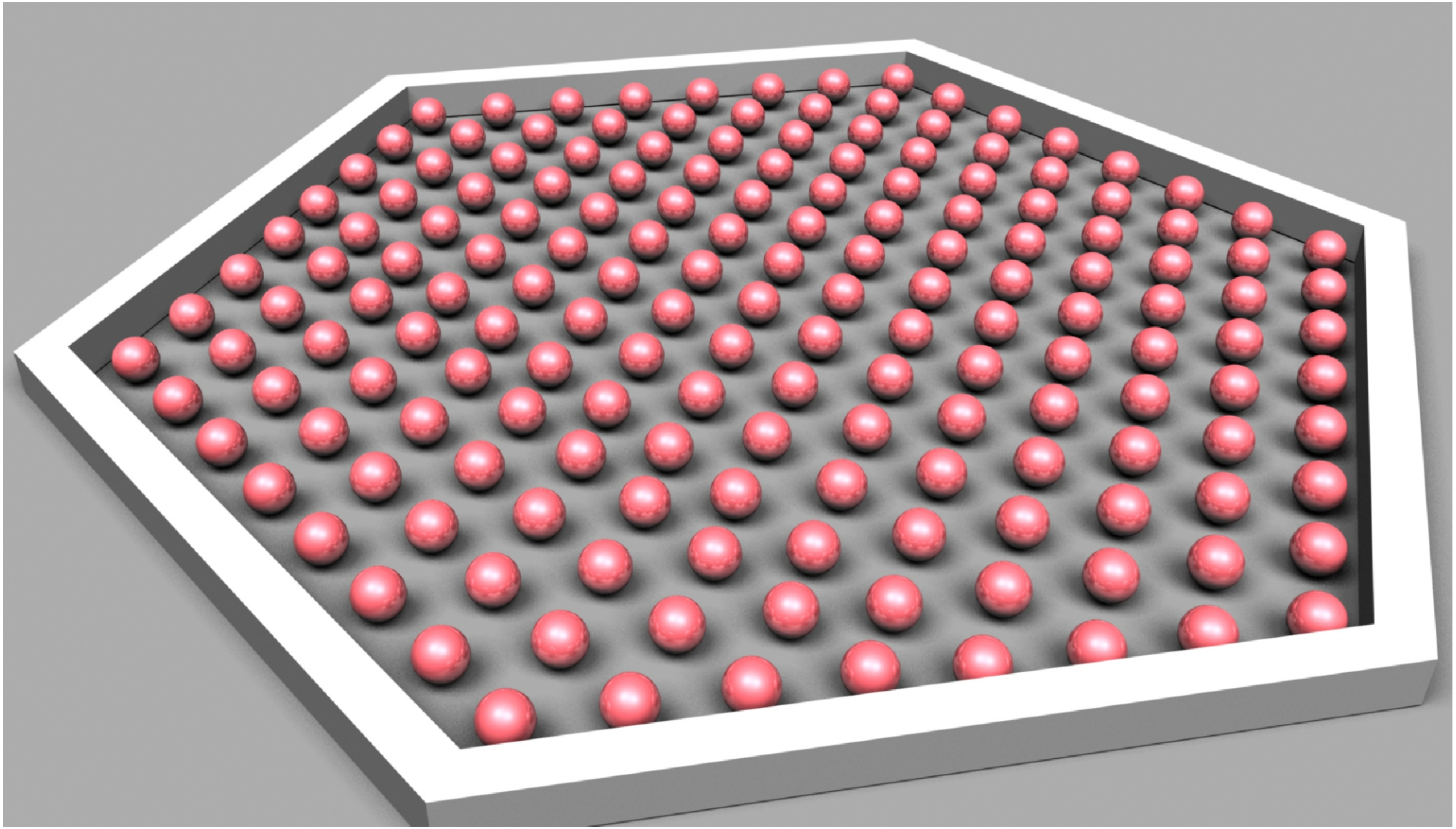
Spin cast diblock copolymer layer onto the patterned substrate and anneal to obtain equilibrium order

Melting of 2D vs 3D Block Copolymer

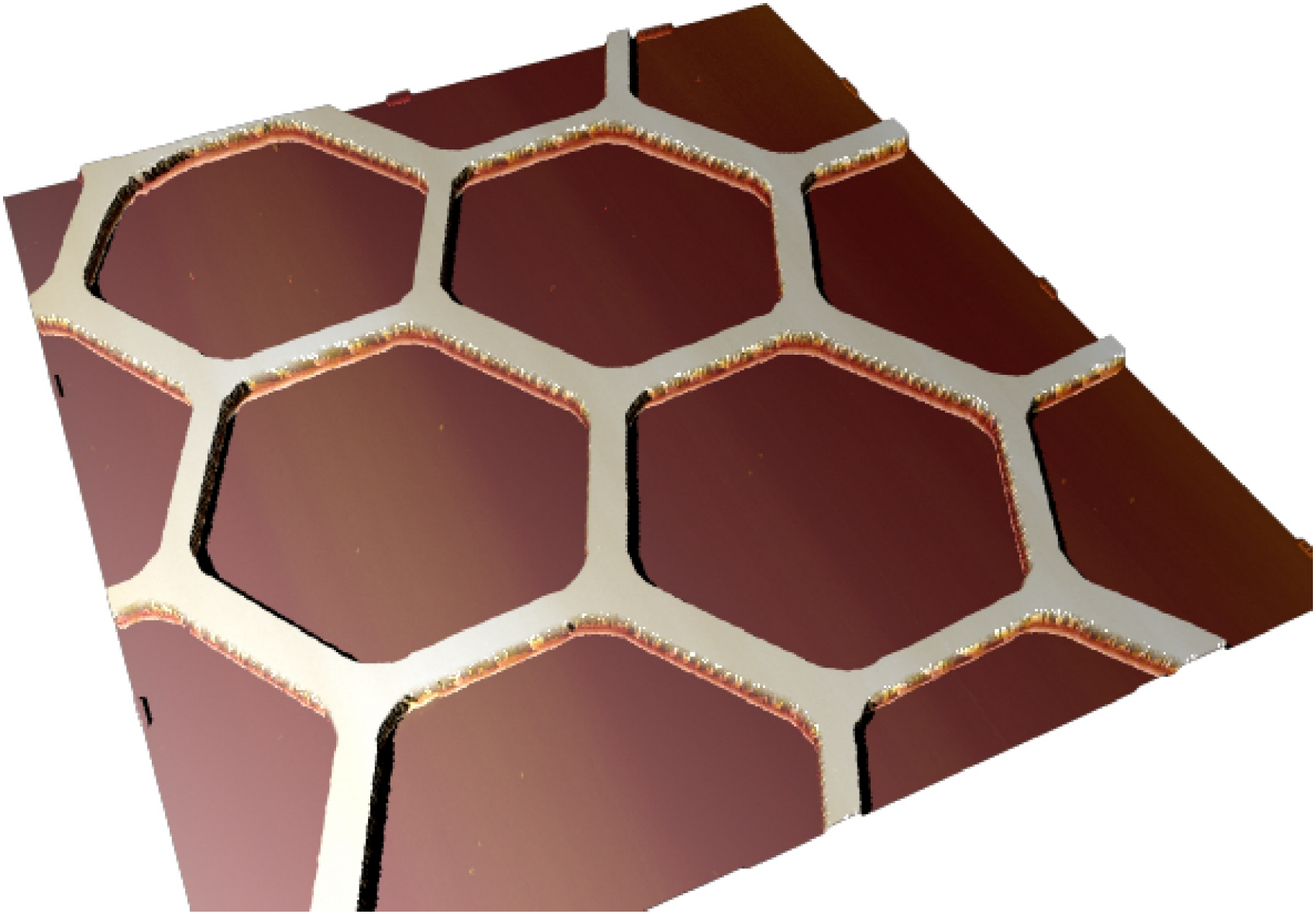


Segalman, R.A., Hexemer, A., Hayward, R.C., Kramer E.J.; Macromolecules 36 (9): 3272-3288,2003

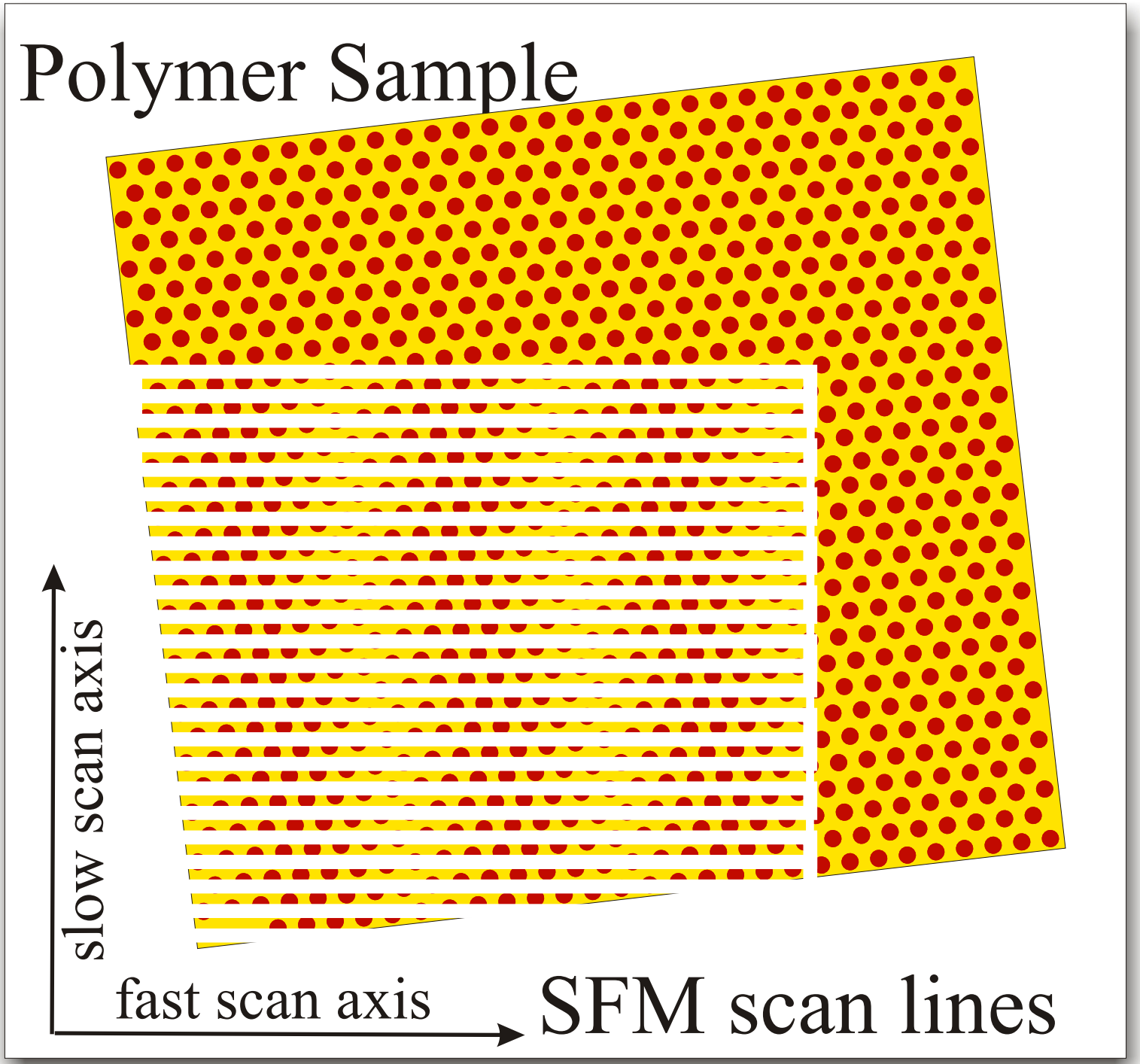
Hexagons



Hexagons

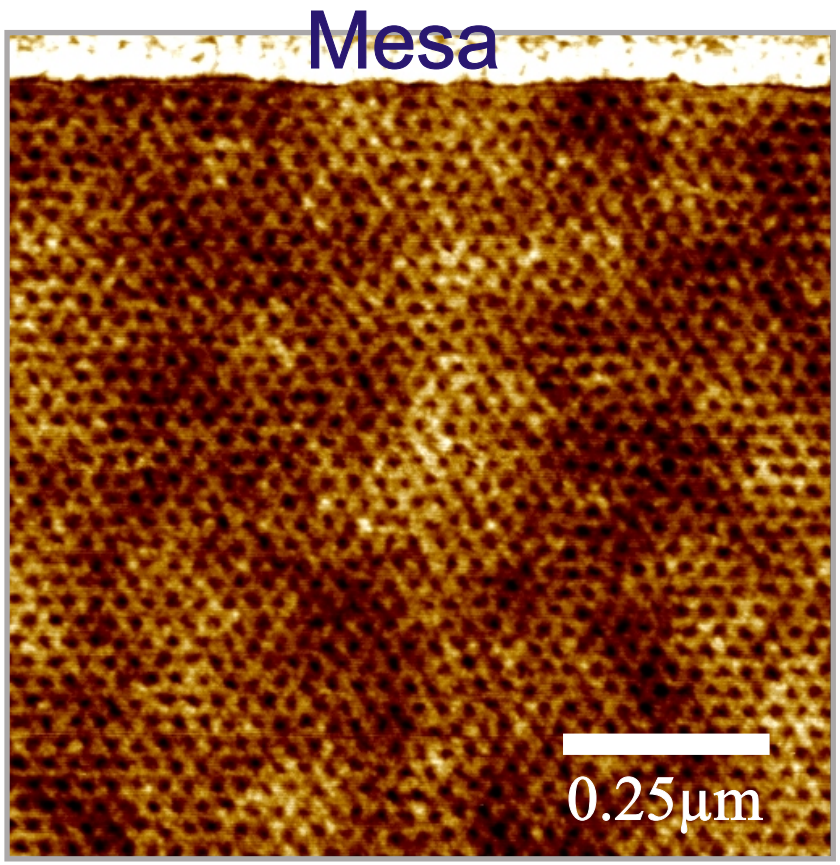


SFM Moiré

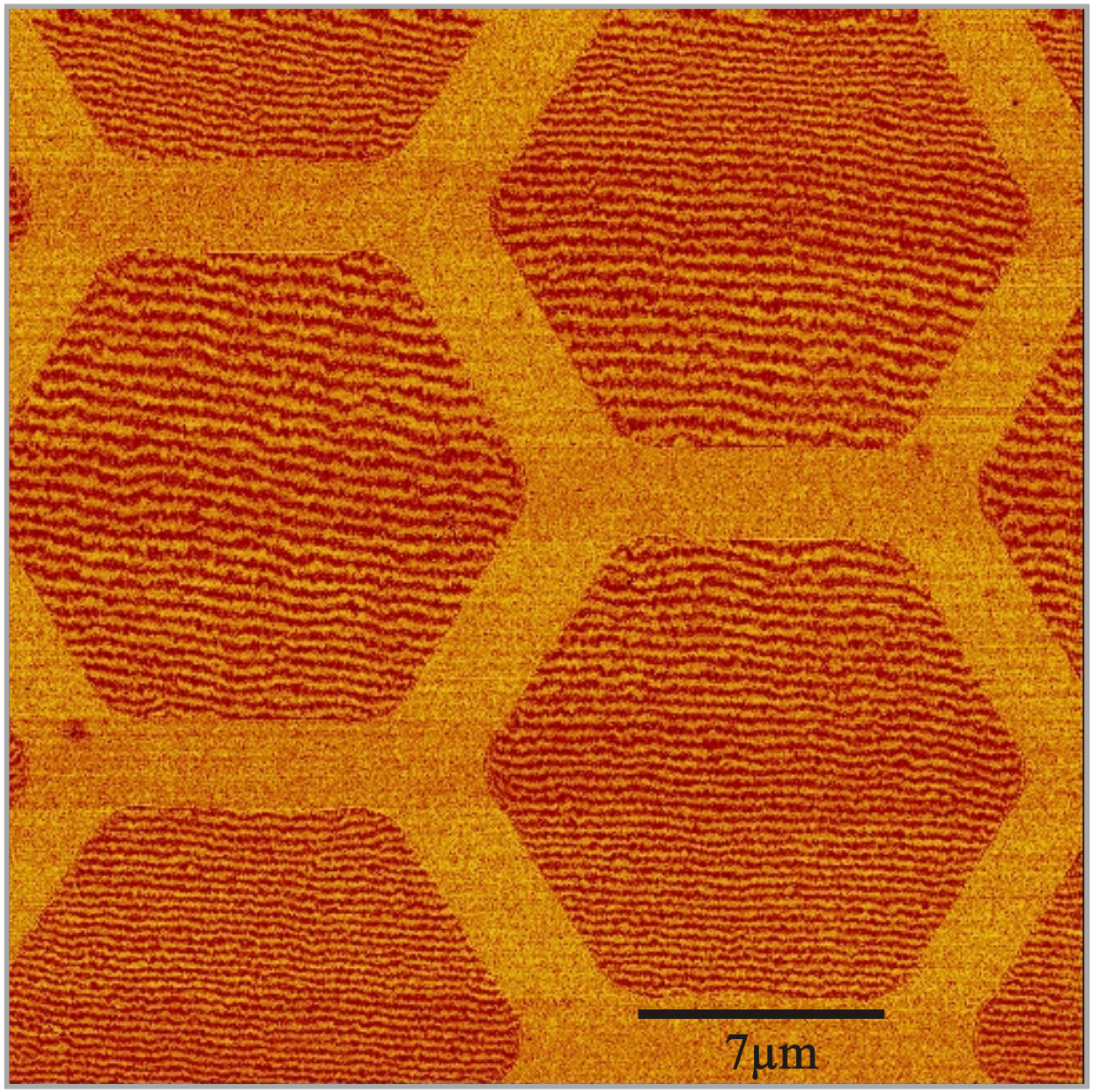


SFM Analysis

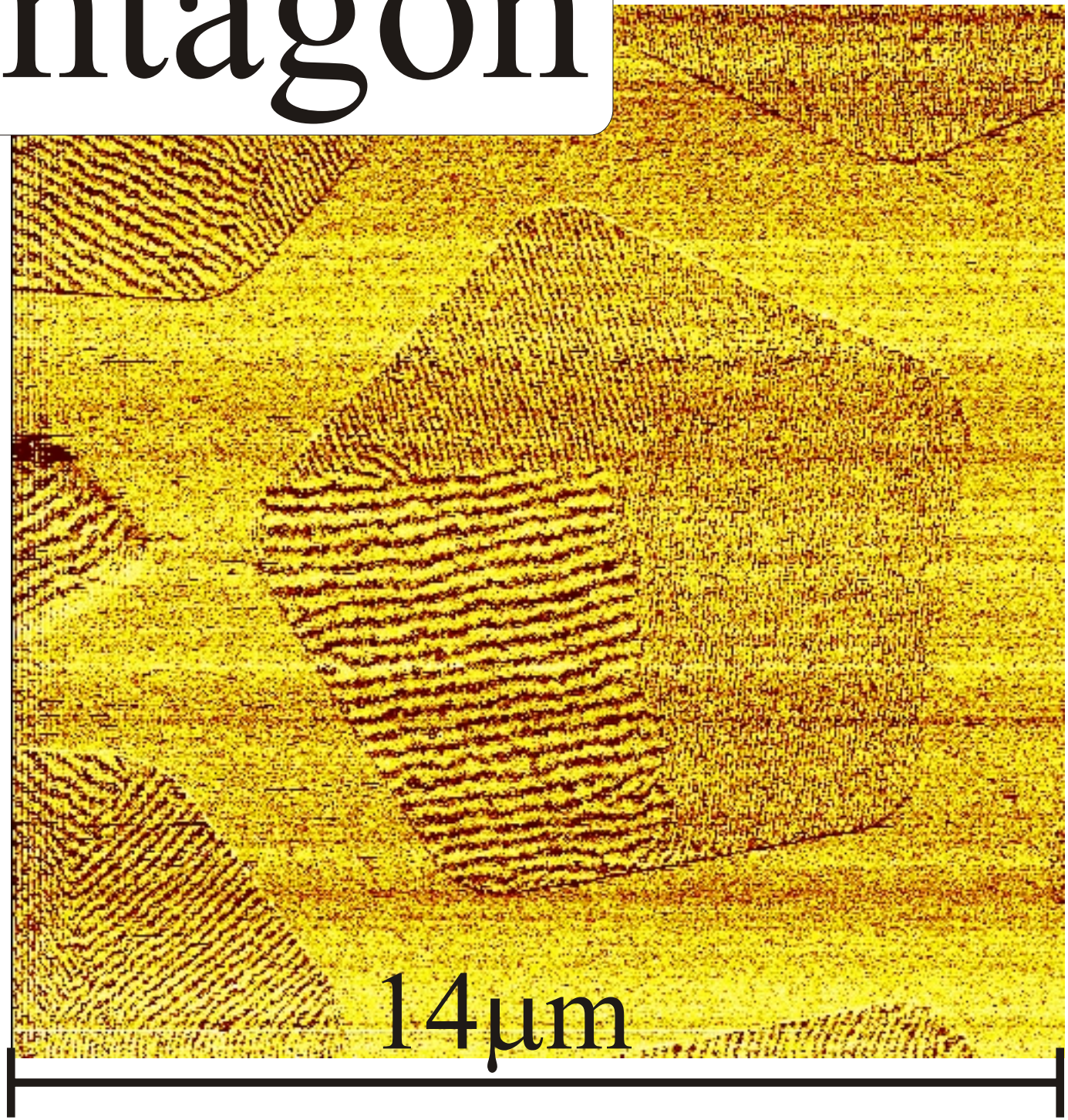
direct image of lattice



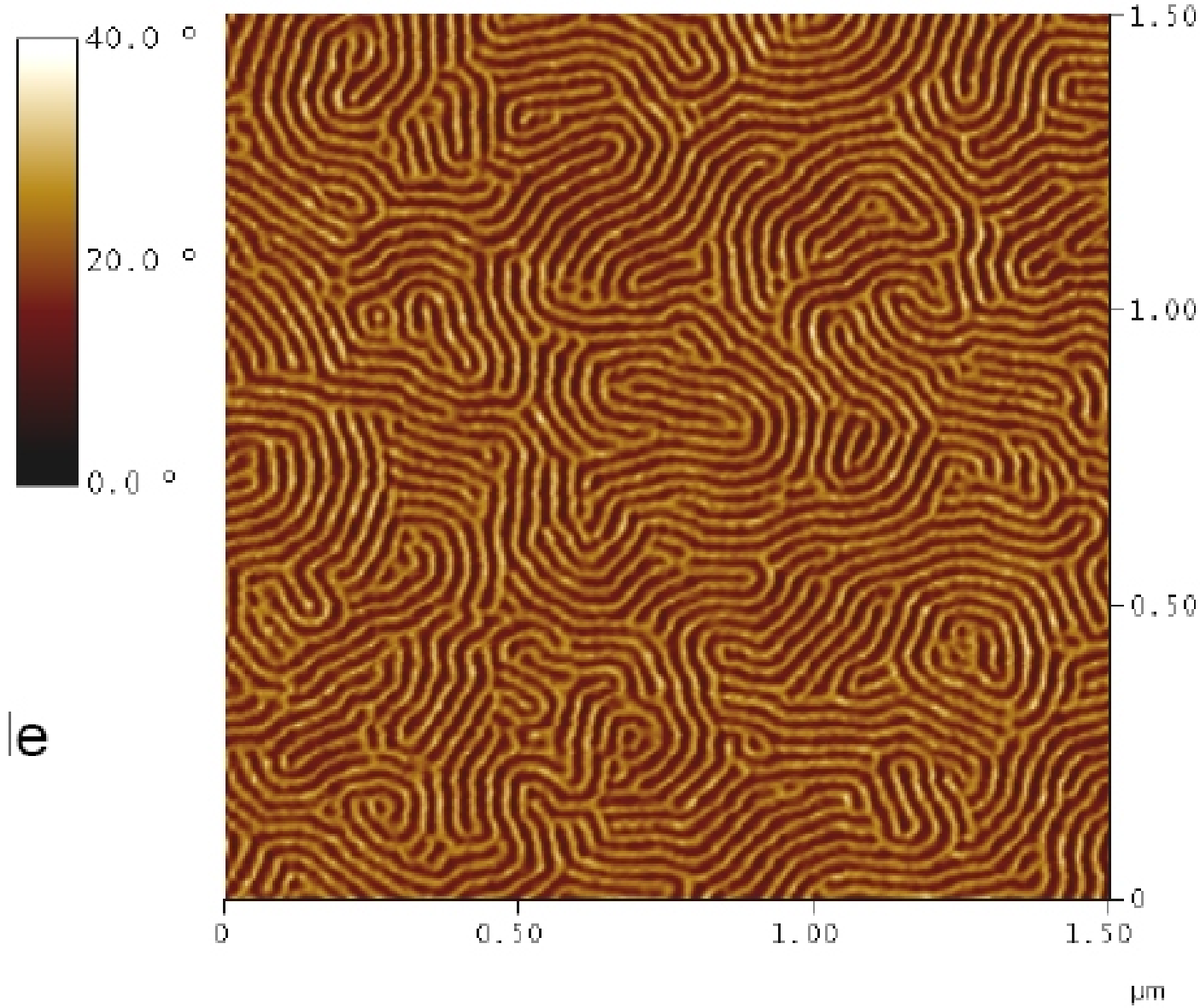
indirect image: moiré interference patterns



Pentagon

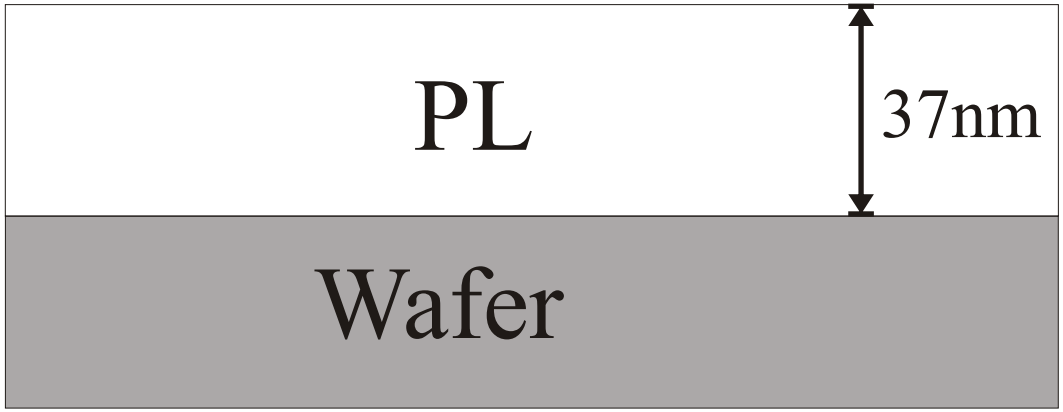


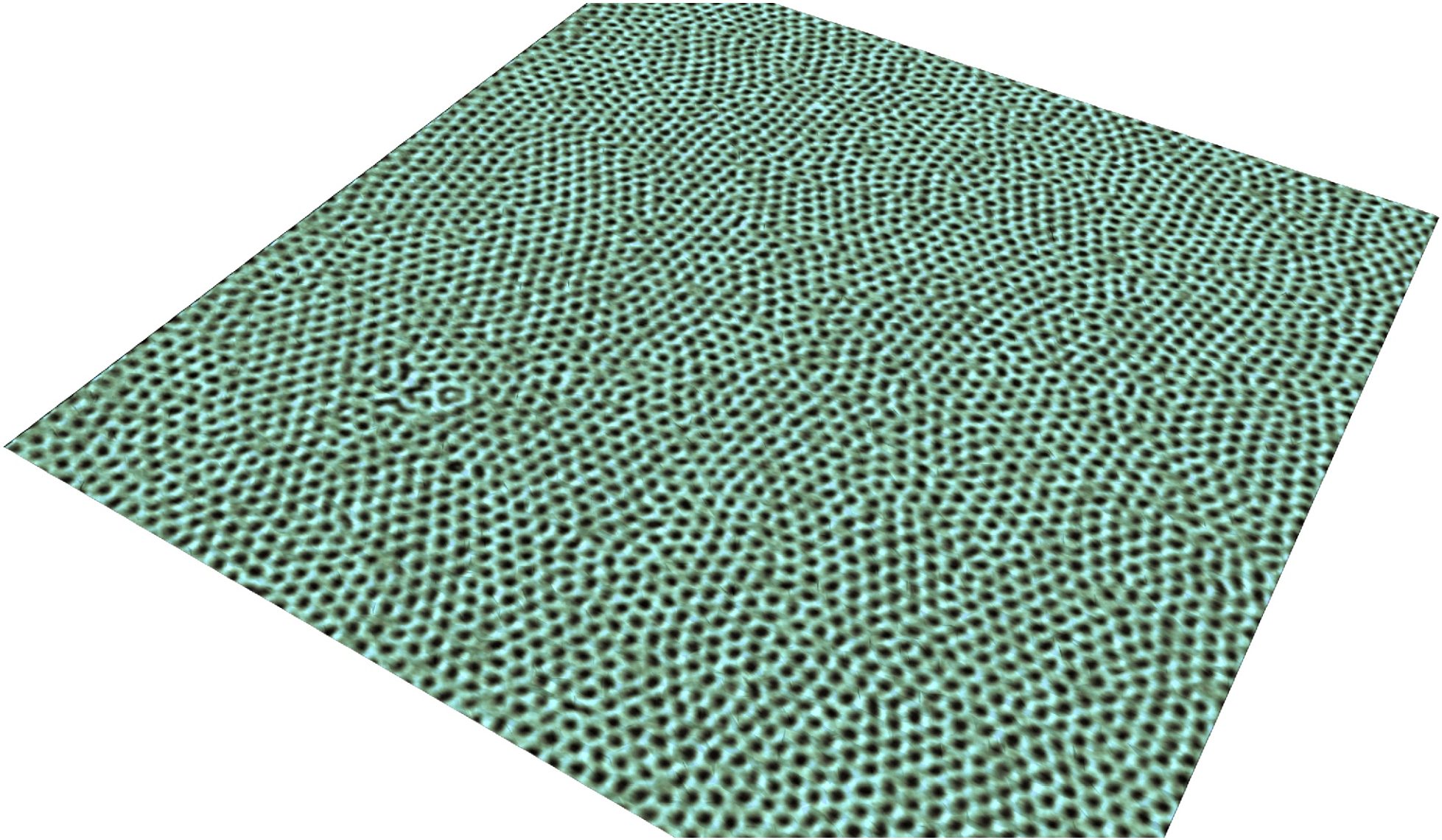
Triblock Copolymer



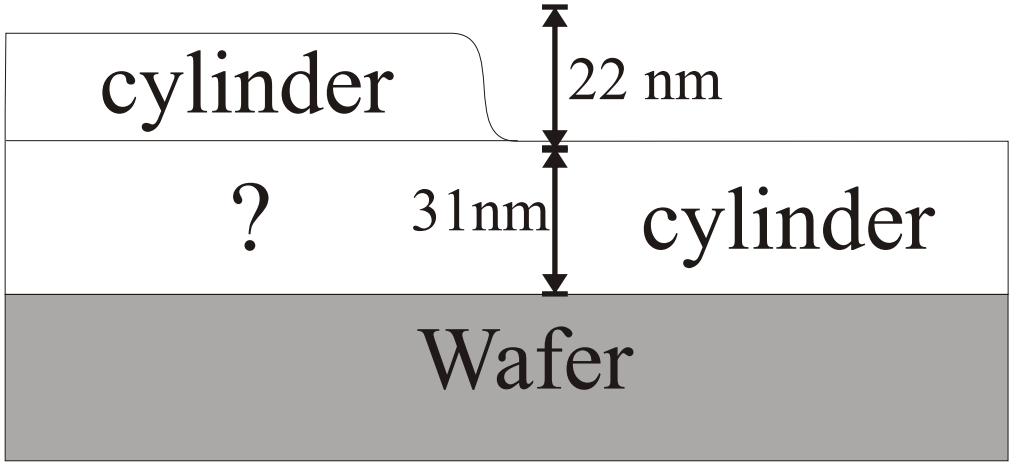
SFM phase image of SEBS surface:
PS cylinders in EB matrix

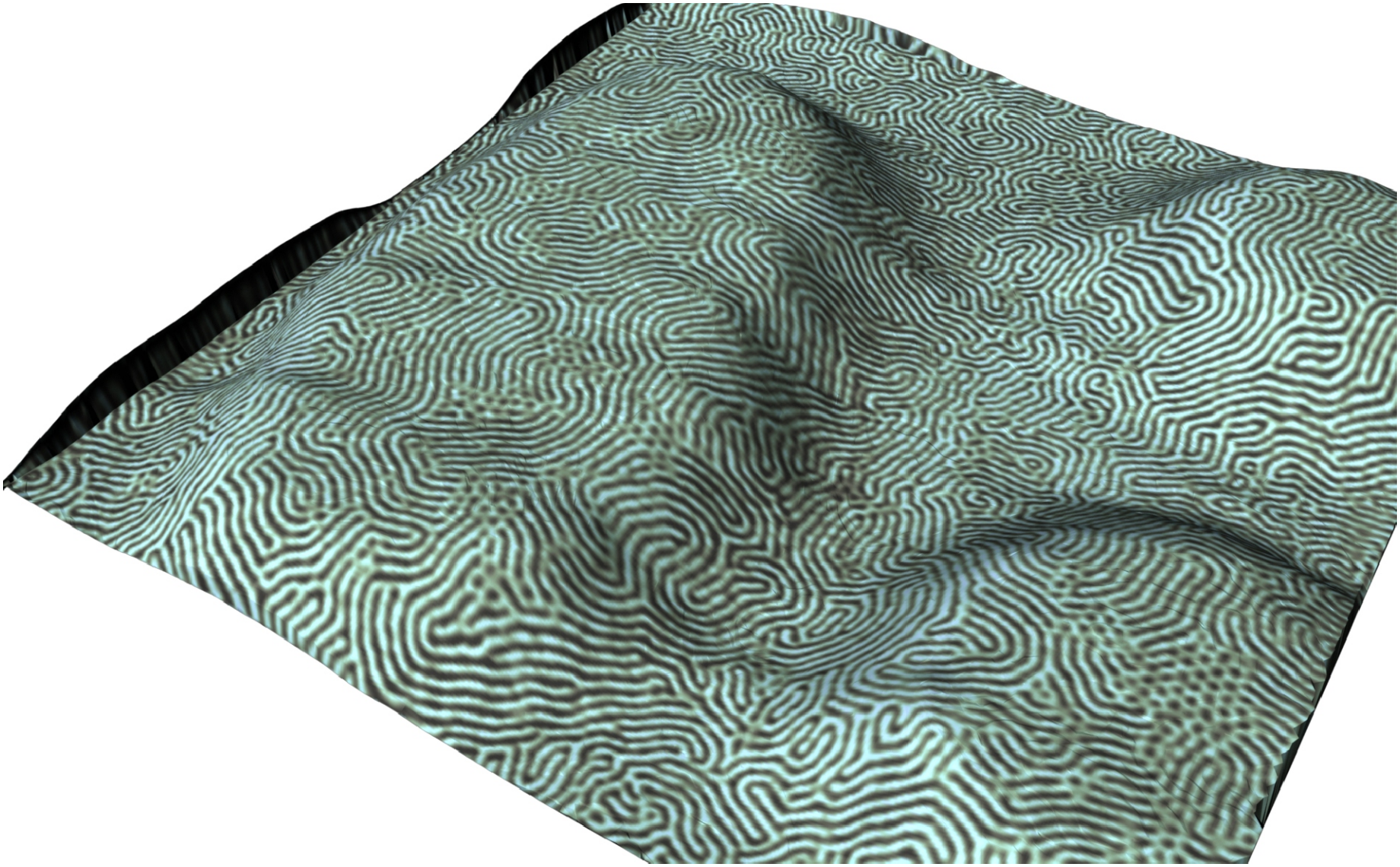
SEBS annealed for 24hrs at 180°C



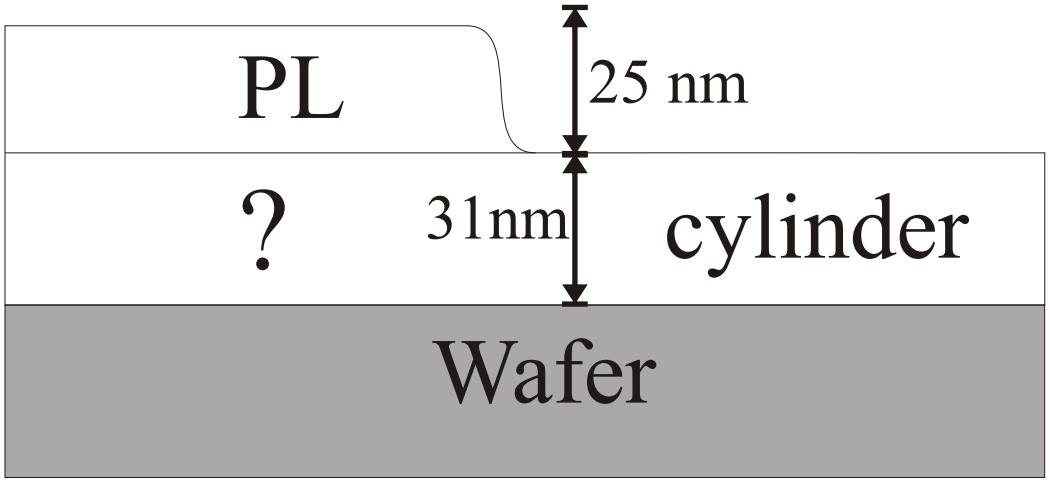


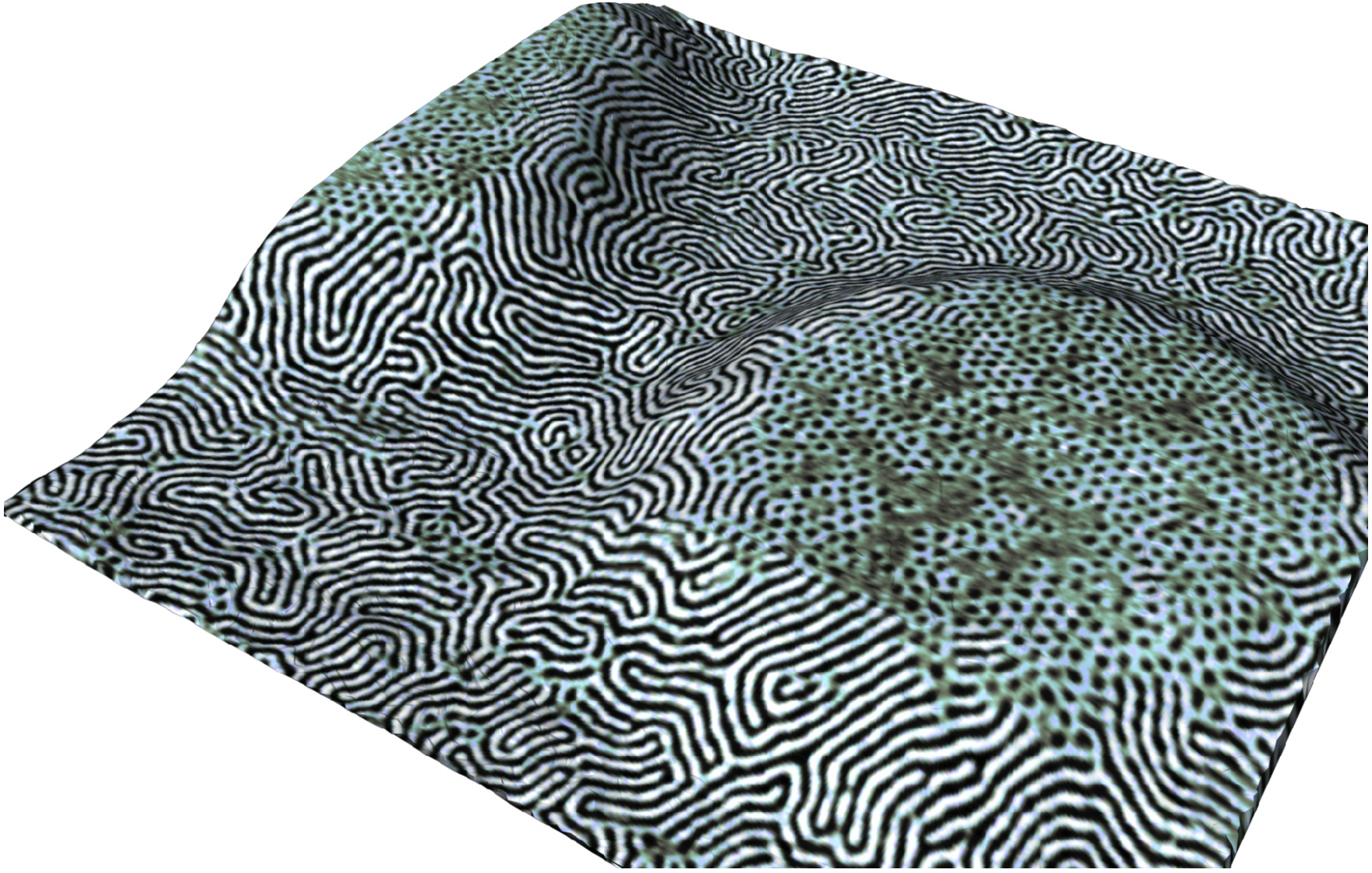
Previous sample re-annealed 24hrs at 210°C



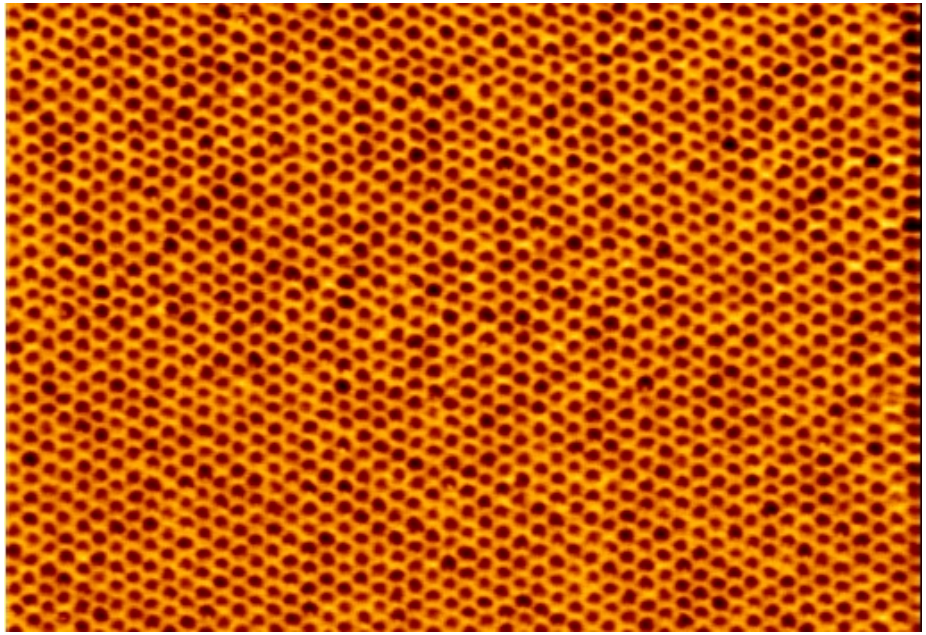


Previous sample re-annealed 24hrs at 180°C

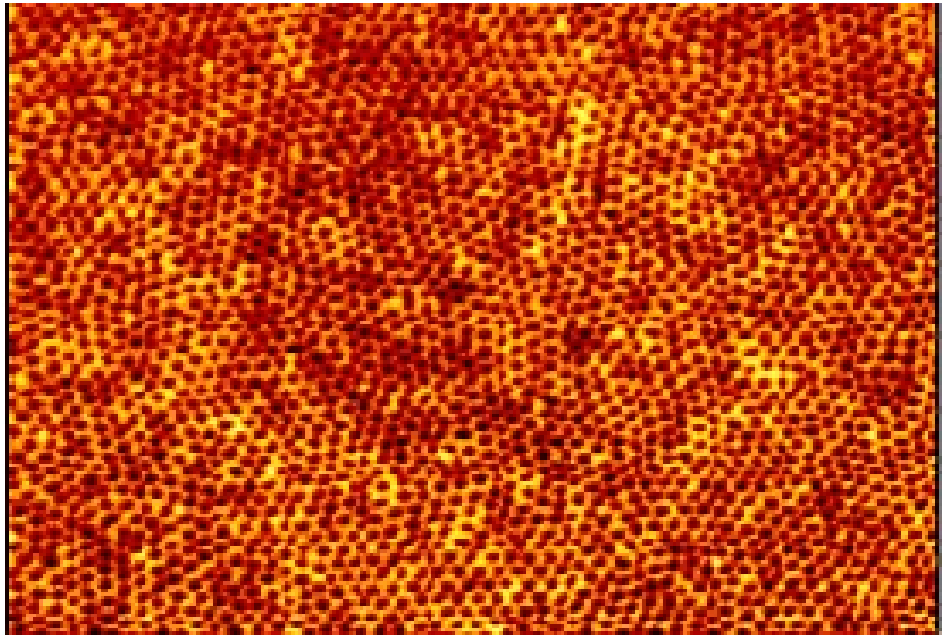




❑ **PS-*b*-PEO**:
long-range ordering character

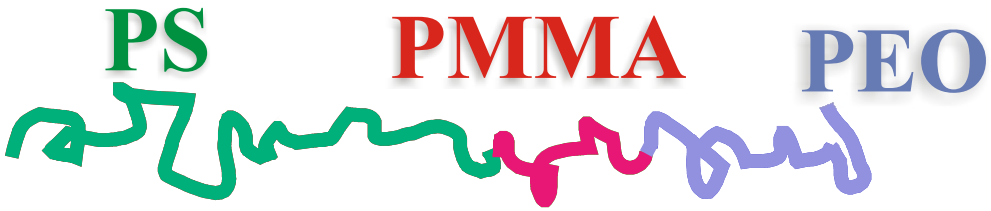


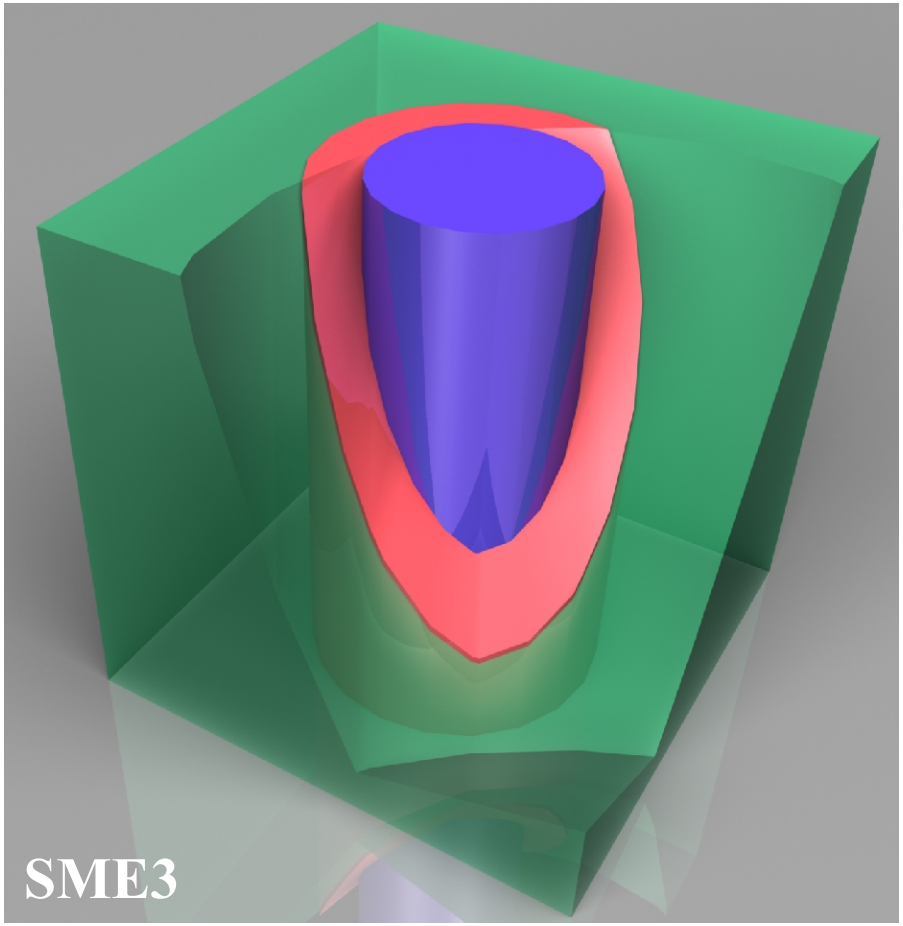
❑ **PS-*b*-PMMA**:
degradability

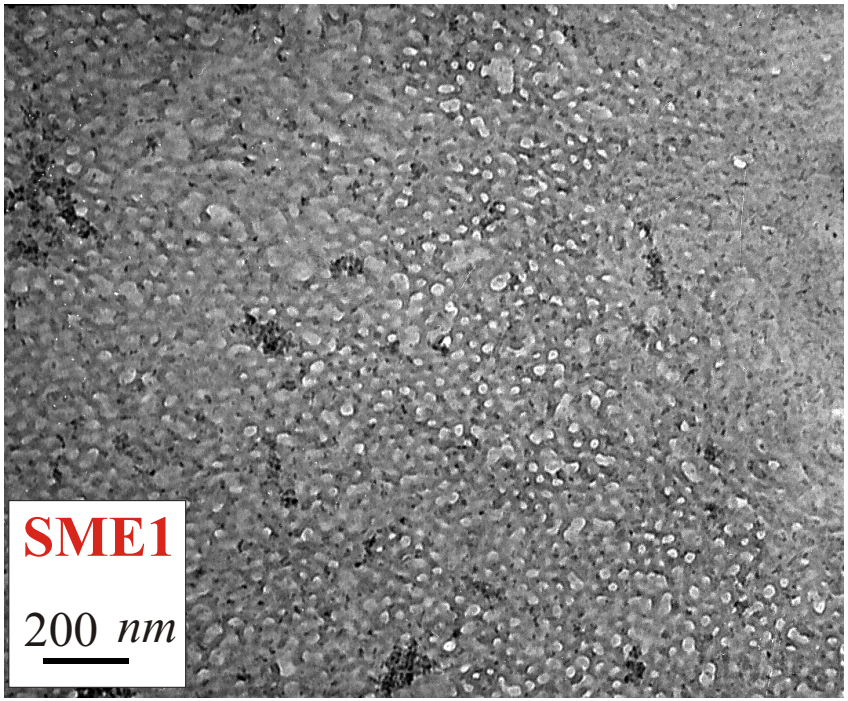


Nanoporous films with arrays of well-ordered nanopores

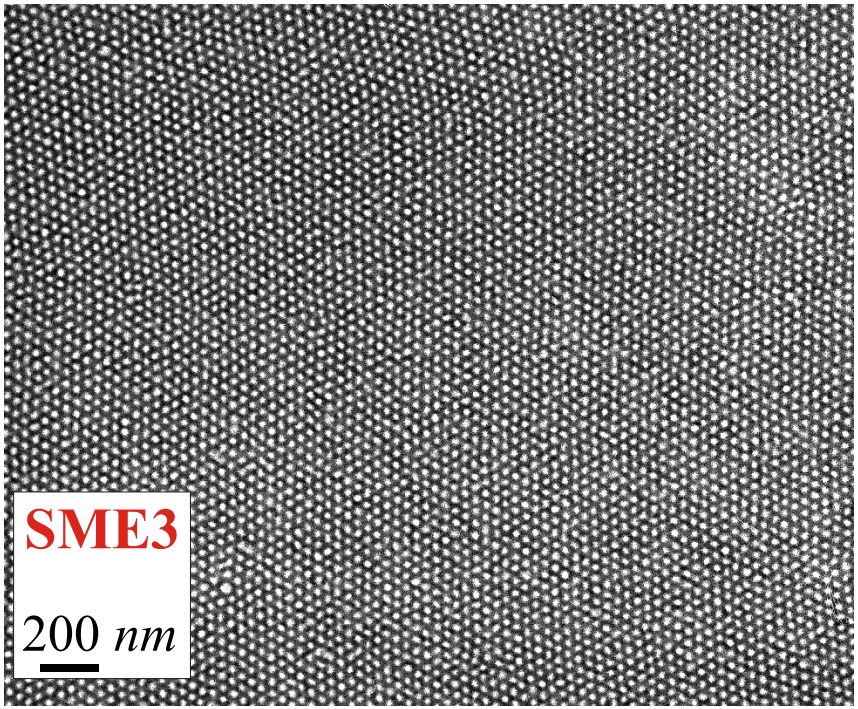
Joona Bang, Eric Drockenmuller, Craig J. Hawker, Seung Hyun Kim, Thomas P. Russell







After UV radiation



Sample ID	M_{PS} (kDa)	M_{PMMA} (kDa)	M_{PEO} (kDa)	f_{PS}	f_{PMMA}	f_{PEO}	M_n/M_w
SME1	13.5	1.5	5.0	0.693	0.068	0.239	1.03
SME3	32.4	6.0	5.0	0.765	0.125	0.110	1.05

Applications for a Soft X-Ray Scattering Beamline

Studying the melting behavior of spherical as well as cylindrical forming block copolymers in various confined geometries

Understanding the mechanisms of phase transitions between different morphologies: spheres to cylinders; perforated lamella to cylinders

Study polymer mixtures of block copolymers with homopolymer

Study multilayer structures