

Investigating the Development of Wrinkle-like Morphologies in Di-block Copolymer Thin Films

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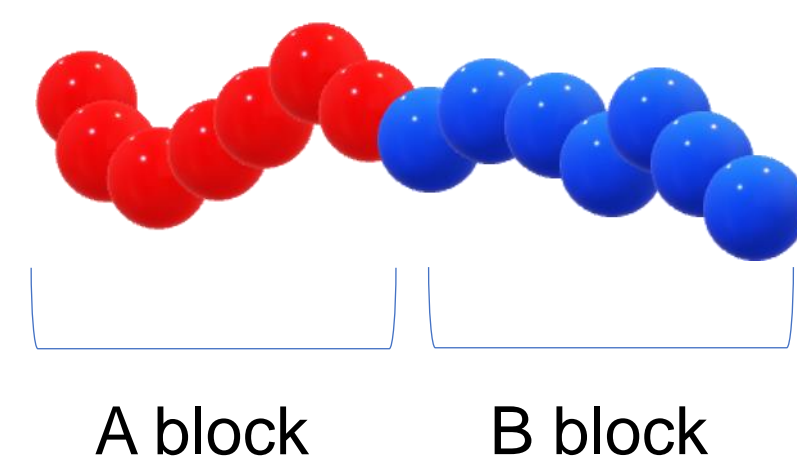
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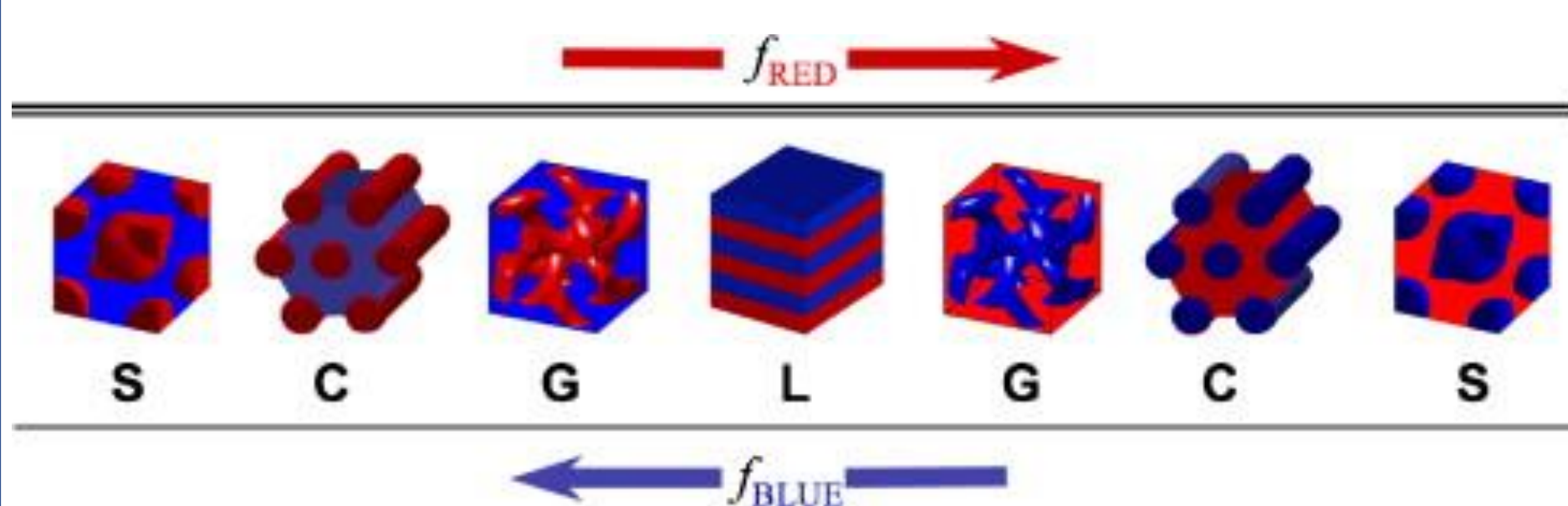
Graduation year: 2021

Introduction

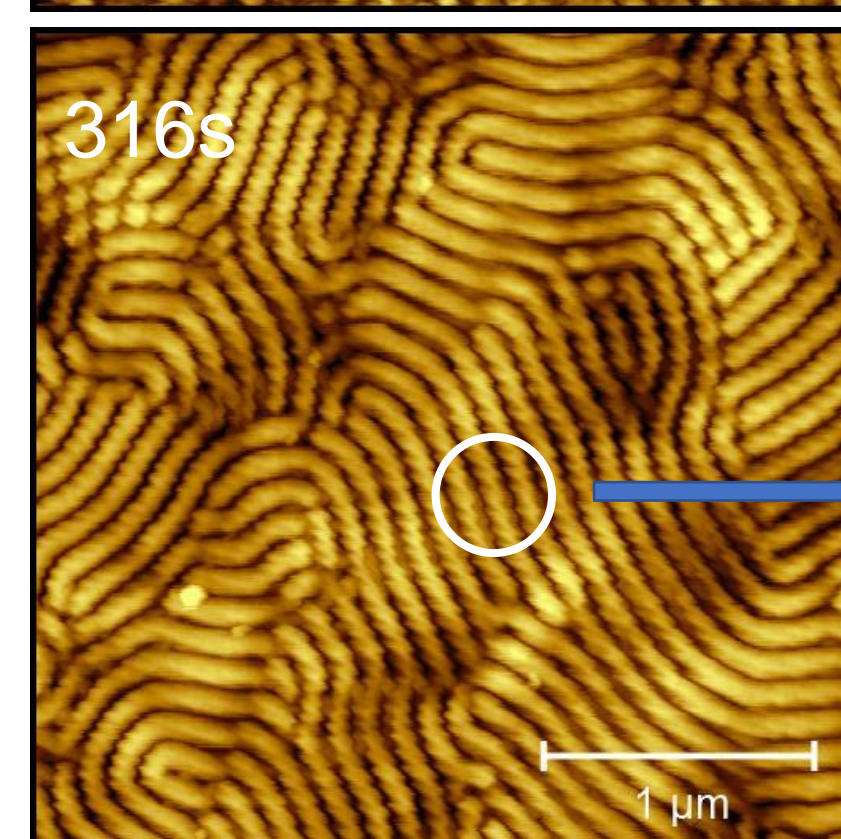
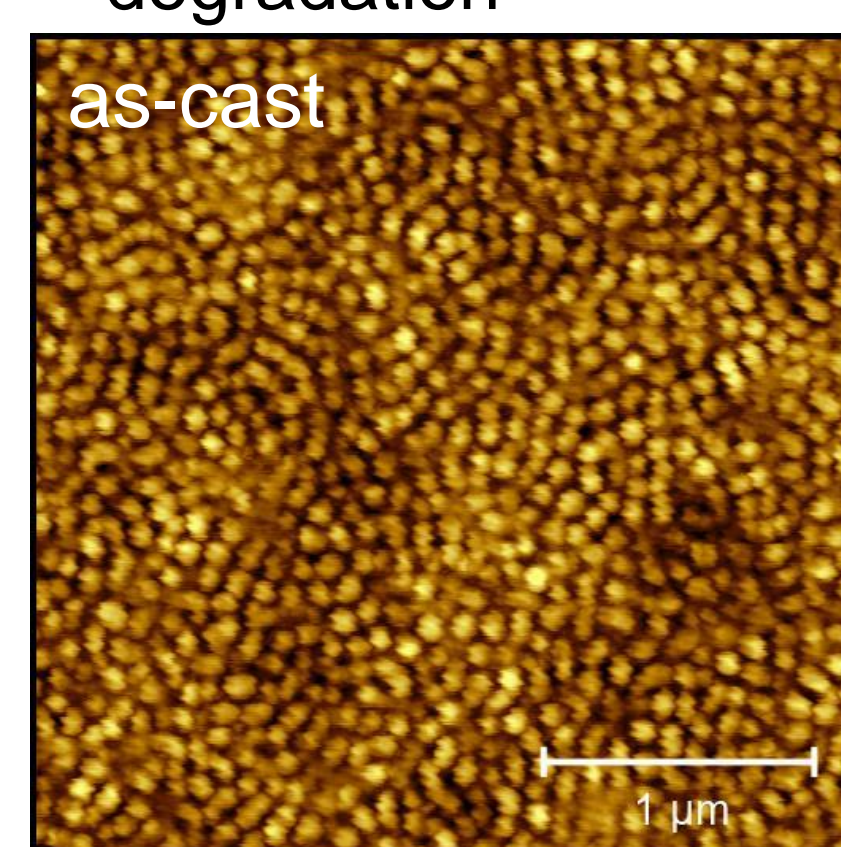
- ❖ Block copolymer class of polymeric materials that consist of two or more 'blocks' of chemically distinct polymer chains



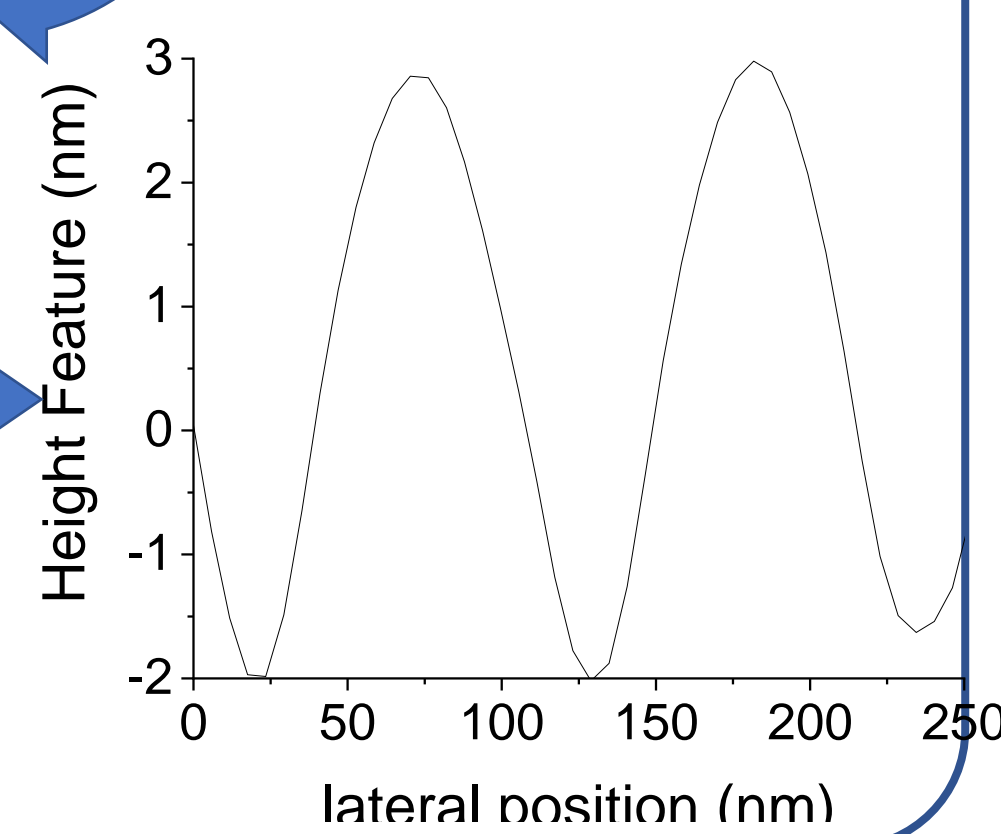
- ❖ Block copolymer self-assembly self-assemble with the same 'block's of polymers and microphase separate into structure when exposed to solvent vapor



- ❖ Solvent Vapor Annealing annealing process to promote the self-assembly of block copolymer by using solvent vapor exposure. This annealing technique is time efficient and safer than thermal annealing, which risks a thermal degradation



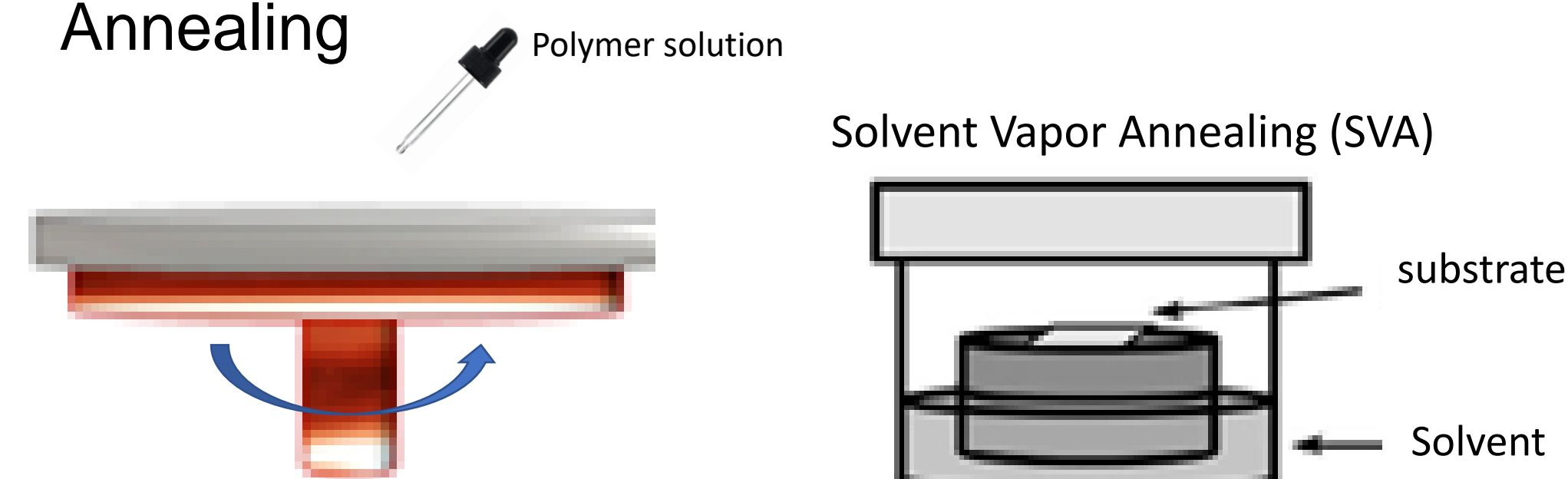
Solvent vapor exposure



3x3 μm^2 images

Experimental Design

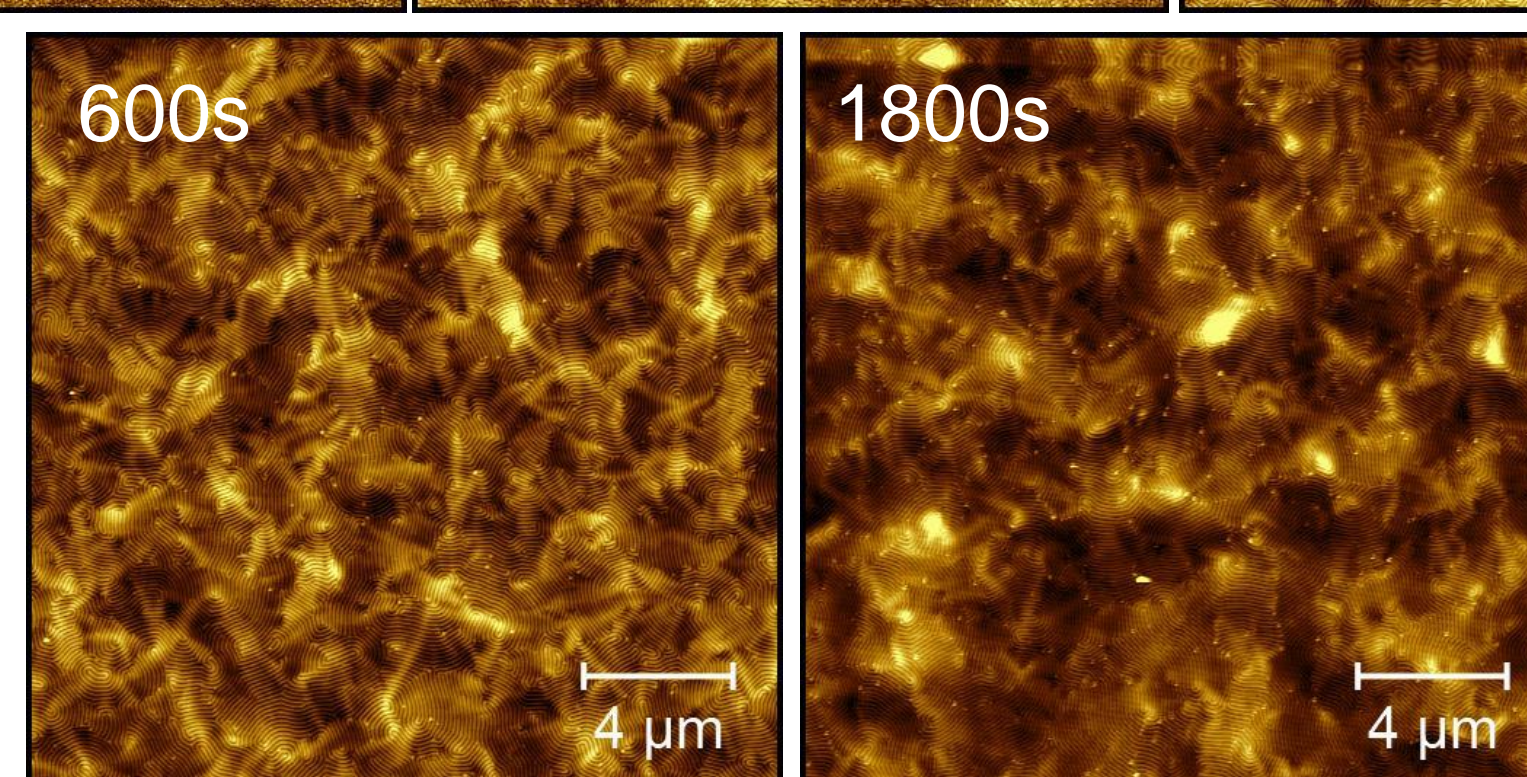
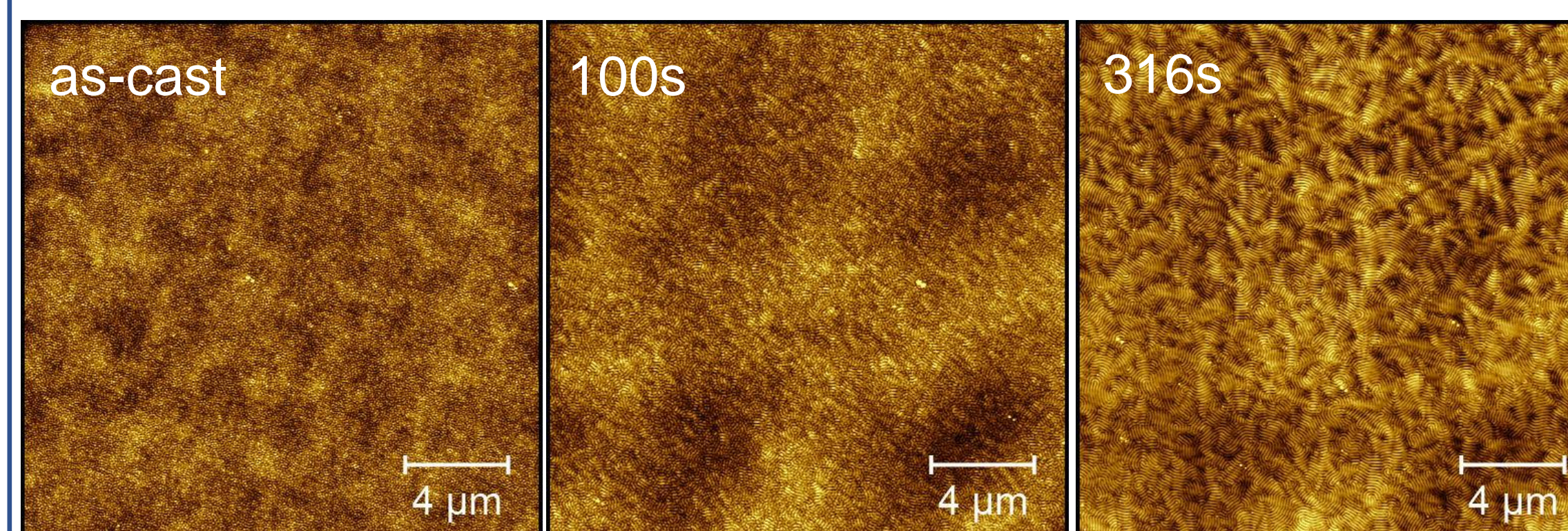
- ❖ Polystyrene-*b*-poly(2-vinyl pyridine) as choice of block copolymer ($M_n = 133,000$ -*b*- $132,000$ g/mol)
- ❖ Film preparation using spin-coating and Solvent Vapor Annealing



- ❖ Use Atomic Force Microscopy (AFM) to obtain images of the film surface
- ❖ Use image processor software Gwyddion to process the images from AFM

Result and Discussion

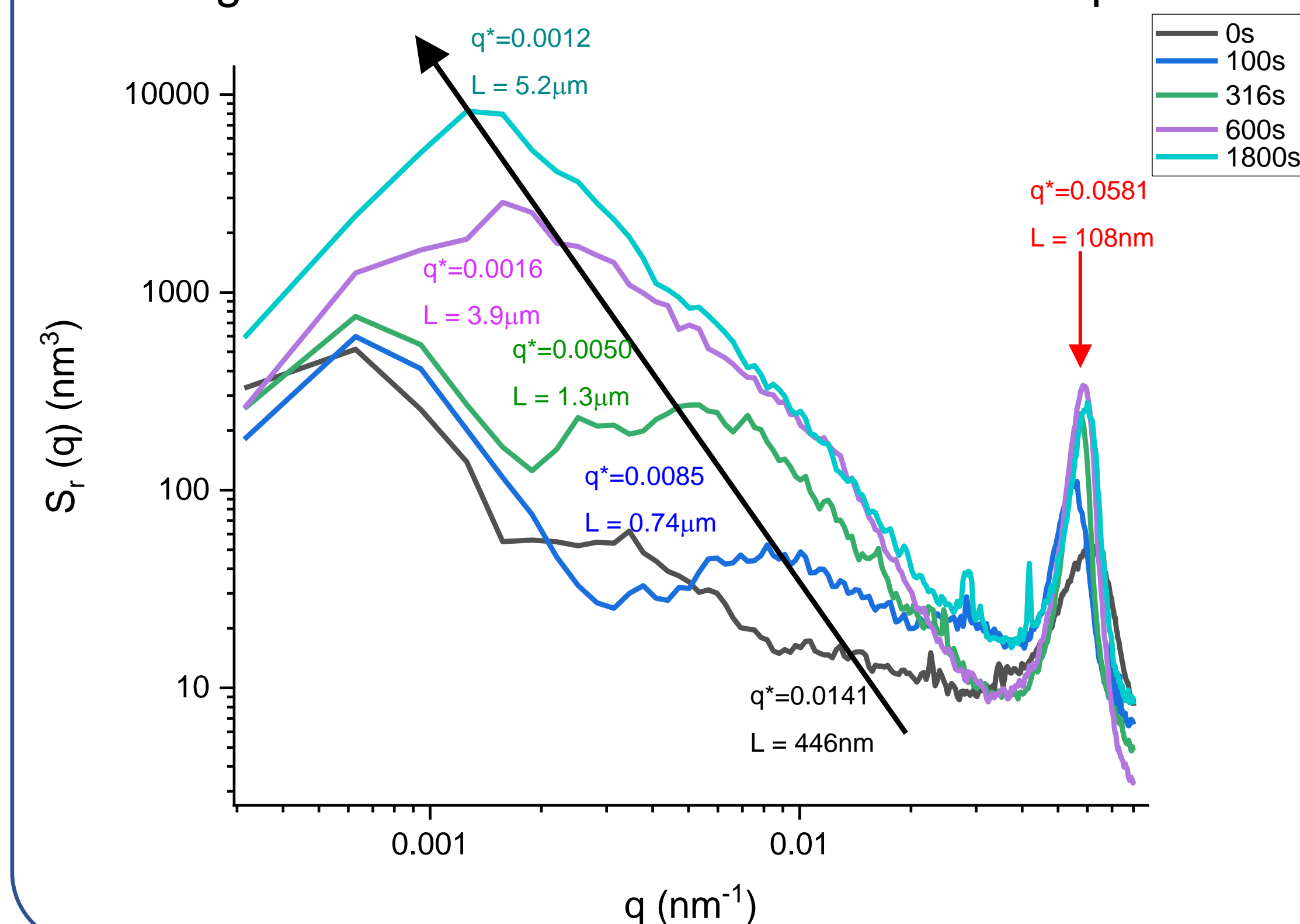
- ❖ Chloroform as selected solvent for SVA
- ❖ The time of solvent vapor exposure varies
- ❖ PS-*b*-P2VP film thickness of ~ 140 nm



20x20 μm^2 images

Result and Discussion

- ❖ Power Spectrum Density Function (PSDF) is the Fourier transform of the lateral autocorrelation function
- ❖ PSDF is used to identify the characteristic lateral length of large features associated with wrinkle-like patterns.



Conclusion

- ❖ As SVA time increases, the large-scale wrinkle-like morphology develops
- ❖ It is speculated that this wrinkle-like morphology is due to the rapid solvent evaporation after SVA
- ❖ Different adsorption rate of polystyrene and P2VP to the silicone oxide substrate might have contributed
- ❖ Future research can be done with slower drying rate for solvent removal

References

1. Lynd, N. A.; Meuler, A. J.; Hillmyer, M. A., Polydispersity and block copolymer self-assembly. *Prog. Polym. Sci.* **2008**, 33 (9), 875-893.
2. Schrode, B.; Bodak, B.; Riegler, H.; Zimmer, A.; Christian, P.; Werzer, O., Solvent Vapor Annealing of Amorphous Carbamazepine Films for Fast Polymorph Screening and Dissolution Alteration. *ACS Omega* **2017**, 2 (9), 5582-5590.