

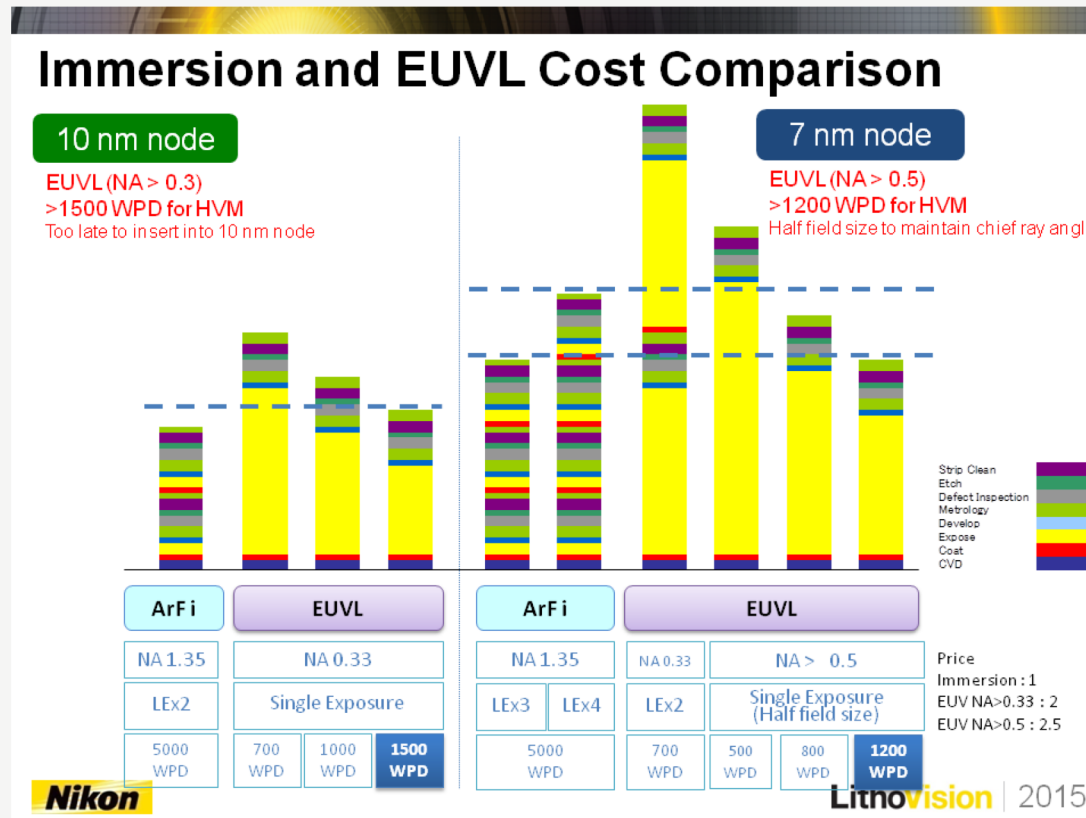


Enabling Pattern Transfer for Block Copolymer Directed Self-Assembly

June 7, 2018 - Maryann C. Tung

















Mentors: Michelle Rincon + Tony Ricco

Lithography Landscape



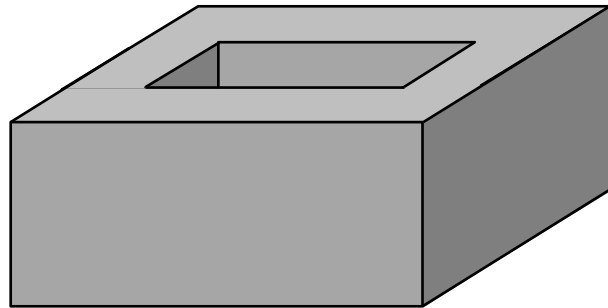
“It’s hard to make things small. It’s even harder to make things small cheaply.” -Chris Mack (PROLITH)

Lithography Landscape

| | Cost | Throughput | Resolution | Defectivity |
|------------------------|---|---|---|---|
| Multiple Patterning |  |  |  |  |
| Extreme Ultraviolet |  |  |  |  |
| Electron Beam |  |  |  |  |
| Directed Self-Assembly |  |  |  |  |

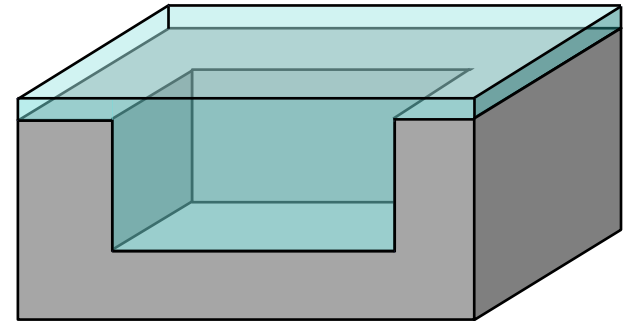
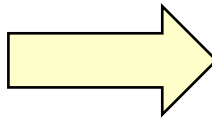
“It’s hard to make things small. It’s even harder to make things small cheaply.” -Chris Mack (PROLITH)

Directed Self-Assembly

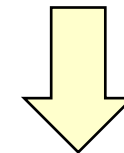


Etched Si template

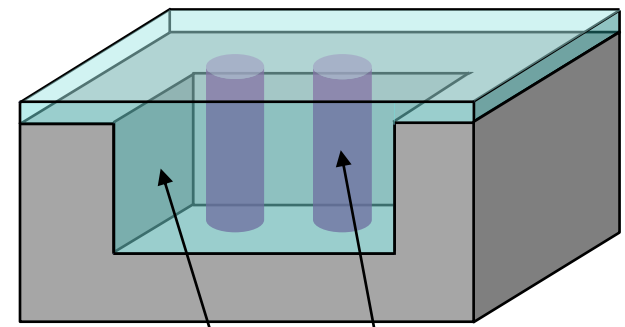
Spin coat



PS-*b*-PMMA film

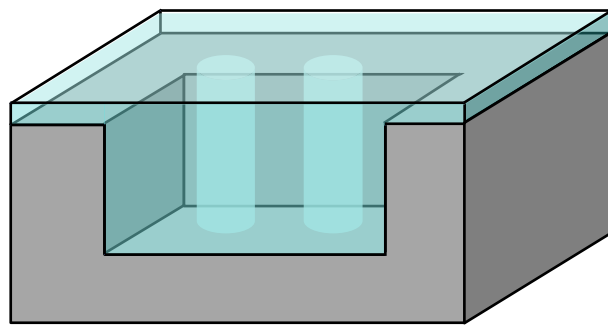
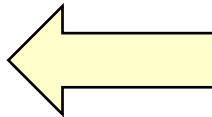


Thermal
anneal



PS PMMA

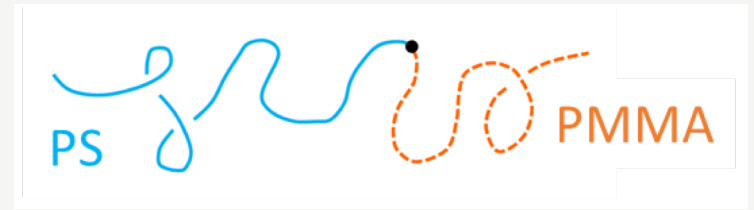
UV radiation
+ acetic
acid soak



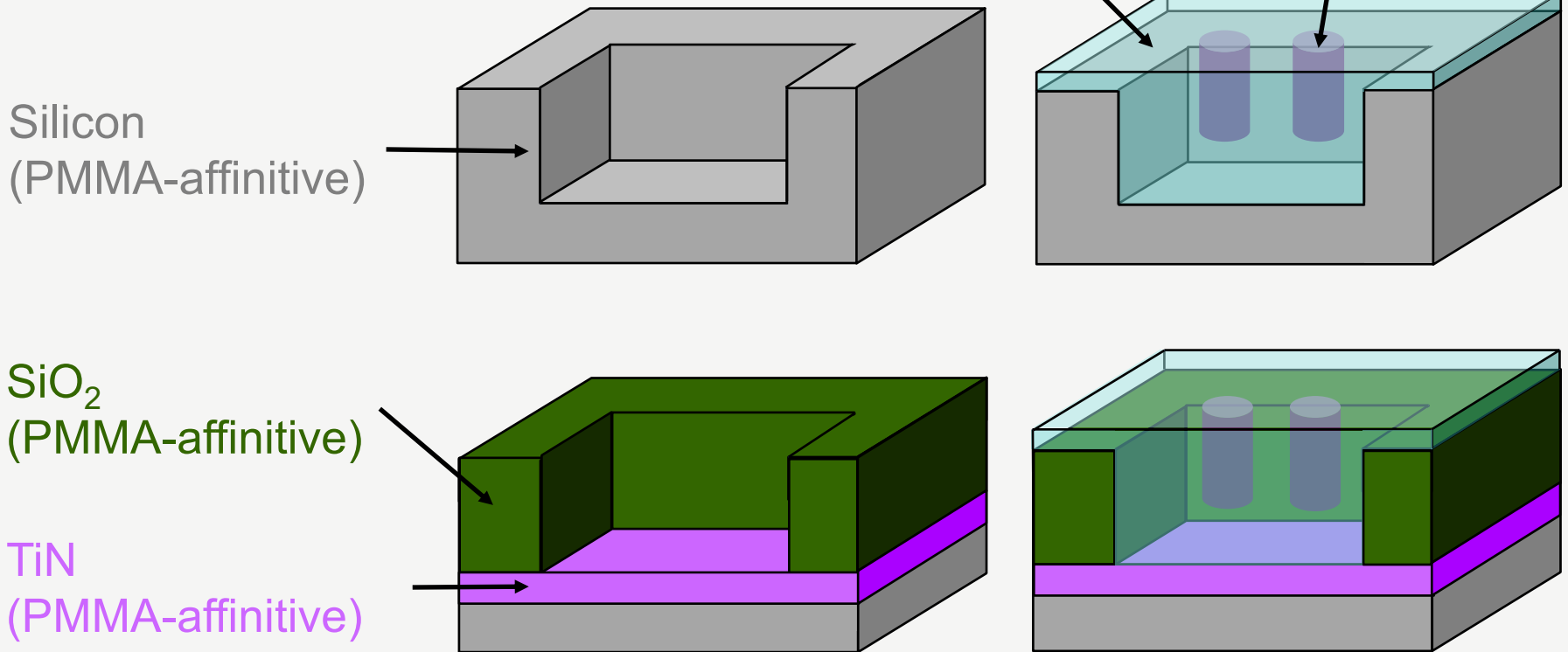
PMMA cylinder removed

Park et al., *Science*, 1997.

Project Goal #1



- Find new guiding template material that enables pattern transfer



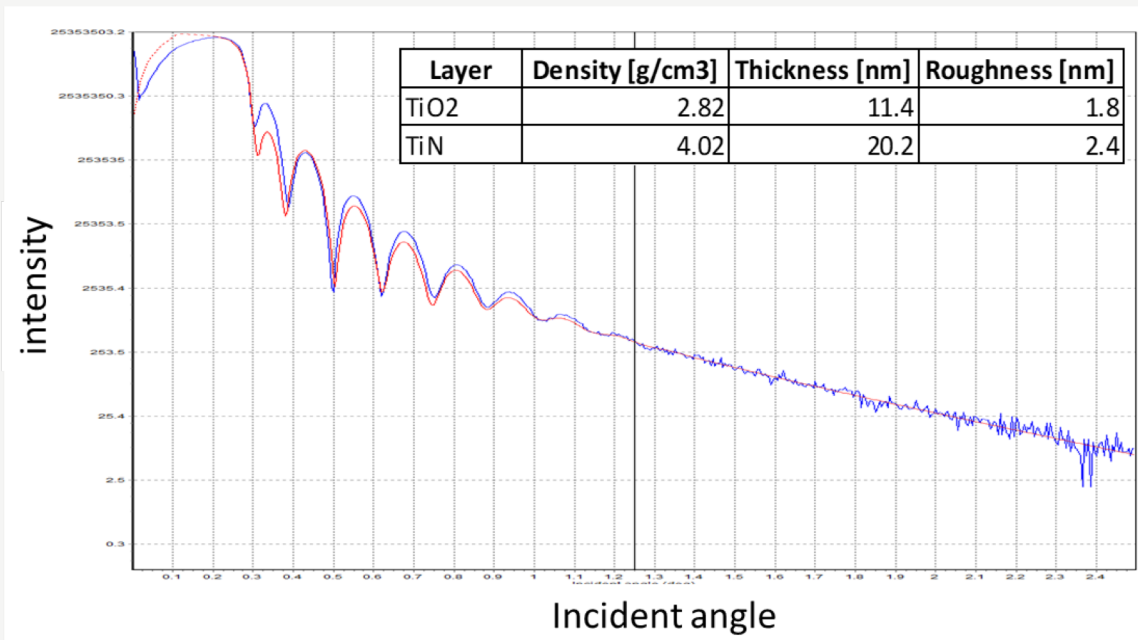
Deposition Steps

- SiO₂: PECVD using standard ccp-dep recipe at 350°C
- TiN: sputtering using lesker in ExFab
 - Initial recipe via Wing Au
 - Pressure: 5 mTorr
 - Gas flow: 10 sccm Ar, 20 sccm N₂
 - Source power: 250 W -> 150 W



Deposition Rates

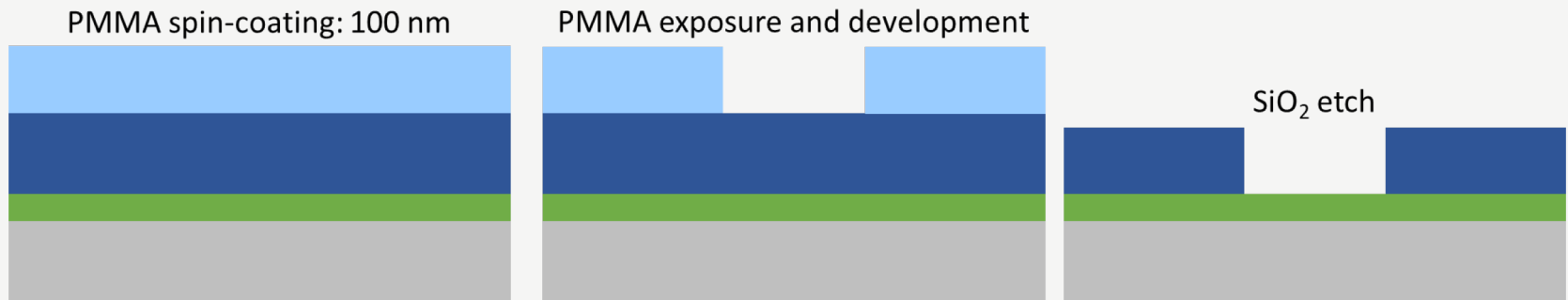
- SiO₂ deposition ccp-dep: 63 nm/min
 - Confirmed via woollam ellipsometer
- TiN deposition in lesker: 32 nm/hr
 - Confirmed via XRR (credit: Karen Kim & Yesheng Yee)



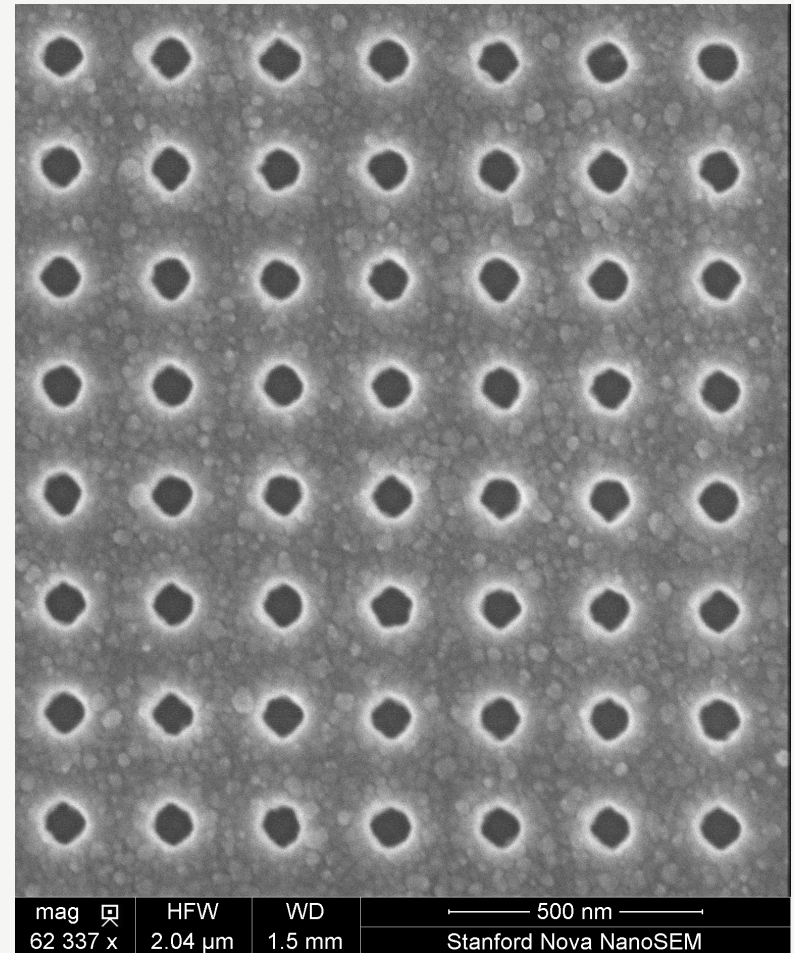
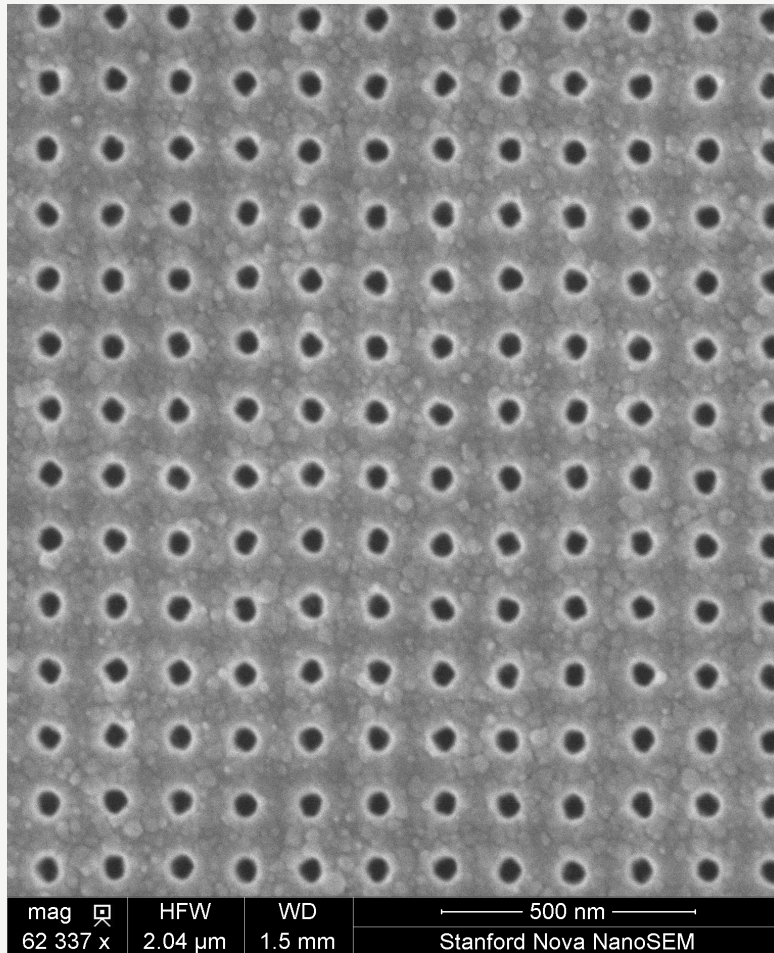
Etching Steps

- SiO₂ etch in oxford-rie: 14.0 nm/min

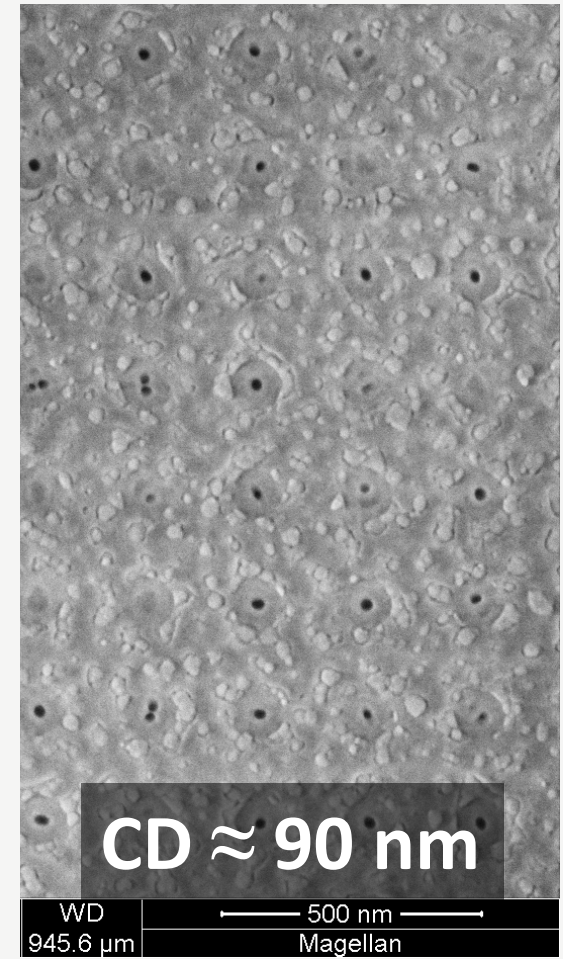
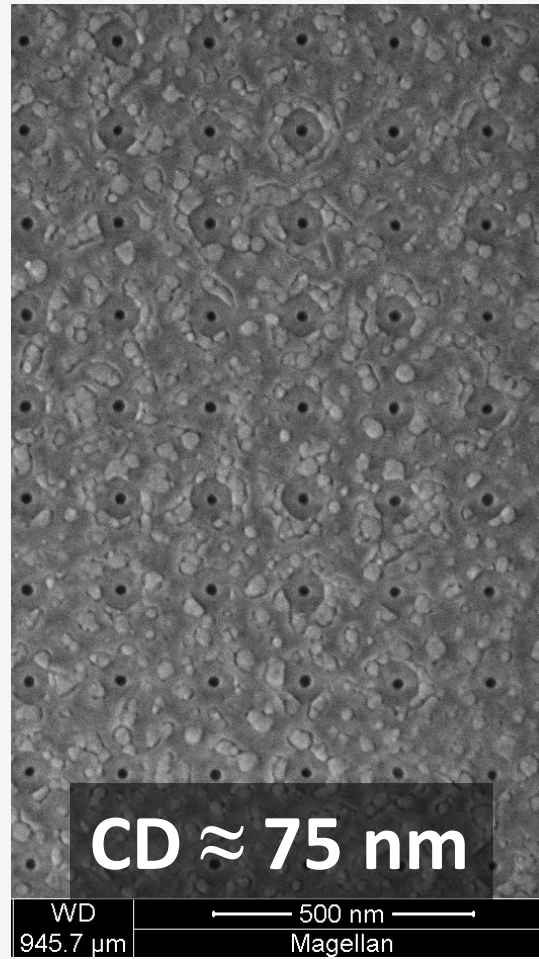
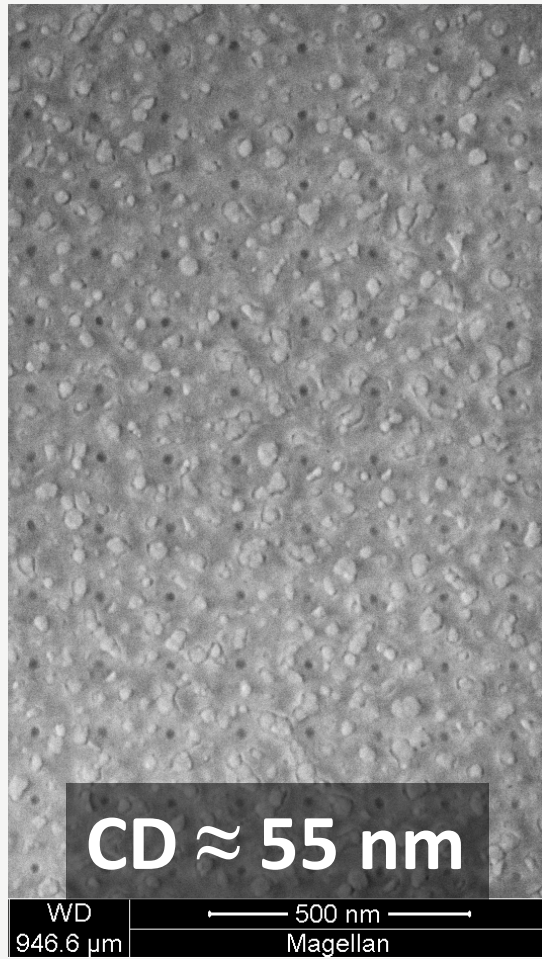
| | Power [W] | Pressure [mTorr] | CHF3 Flow [sccm] | CF4 Flow [sccm] | Ar Flow [sccm] |
|--------------------------|--------------|---------------------|---------------------|--------------------|-------------------|
| Recipe (via Usha) | 50 | 10 | 20 | 5 | 10 |



Template Results



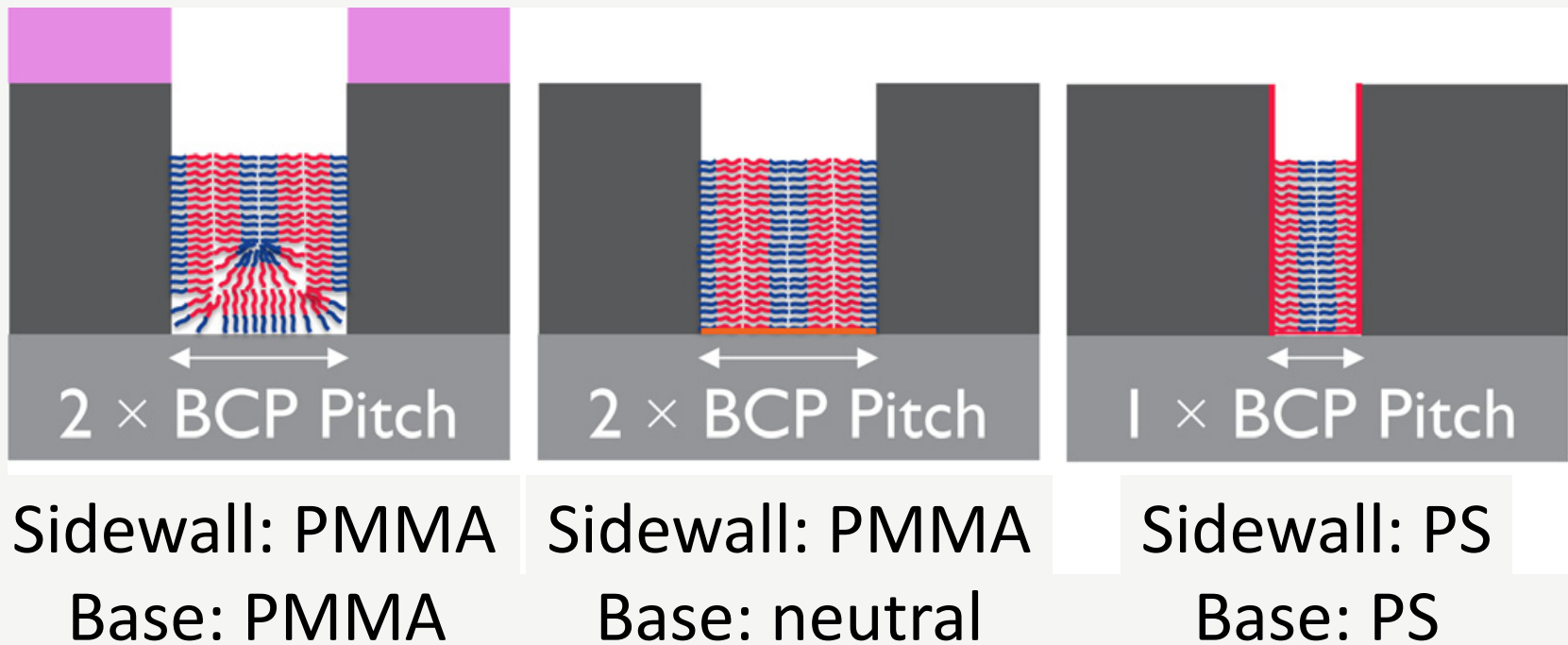
DSA Results



Project Goal #2

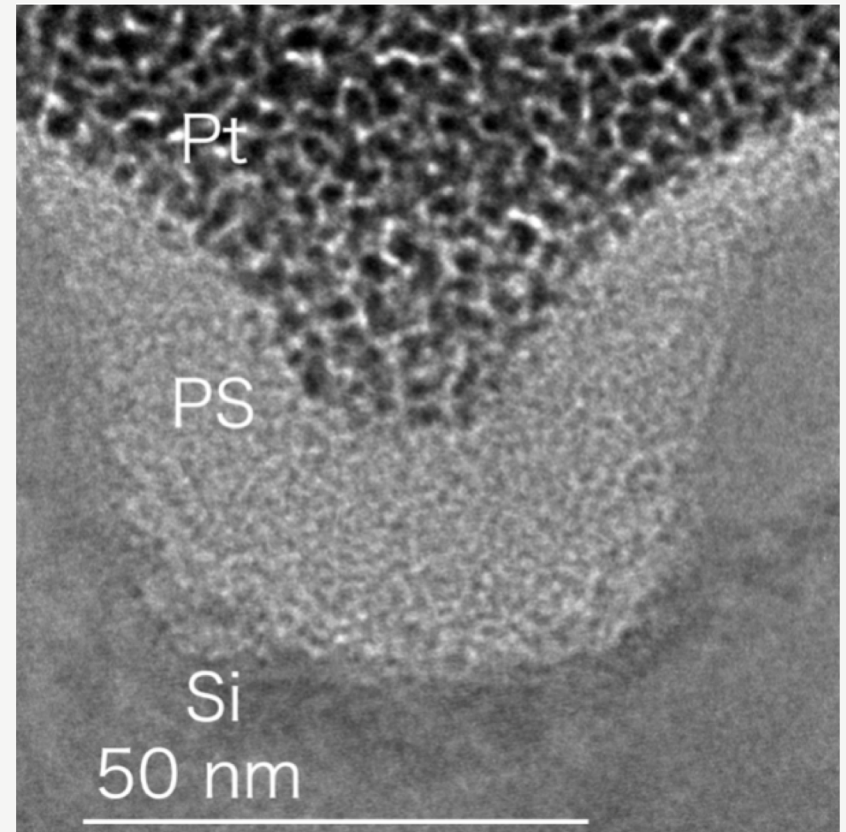
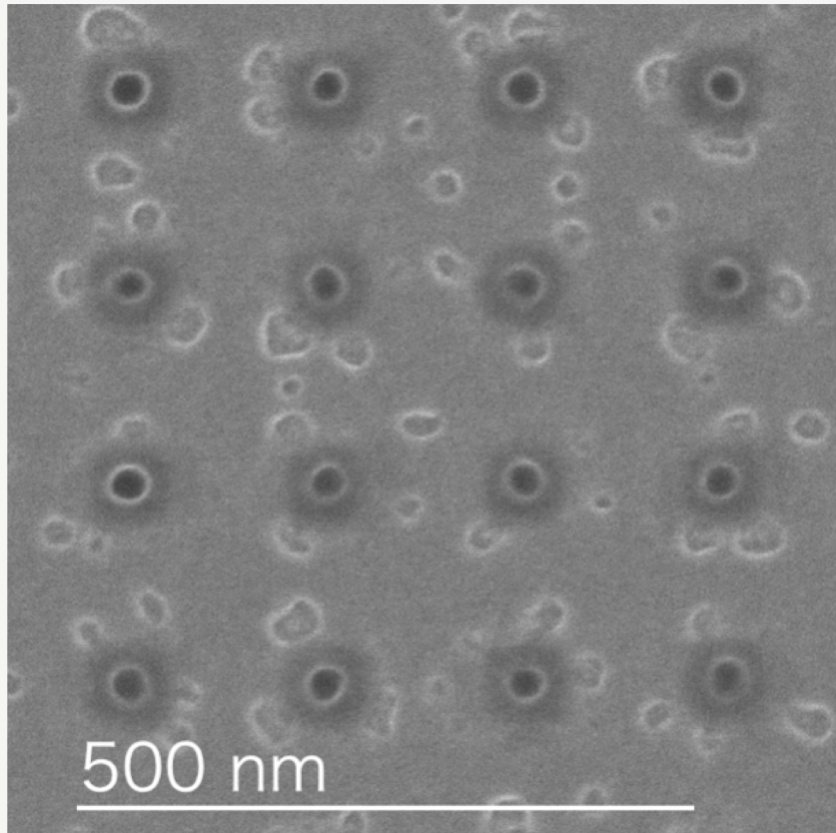


- Modify template surface to allow for easier pattern transfer



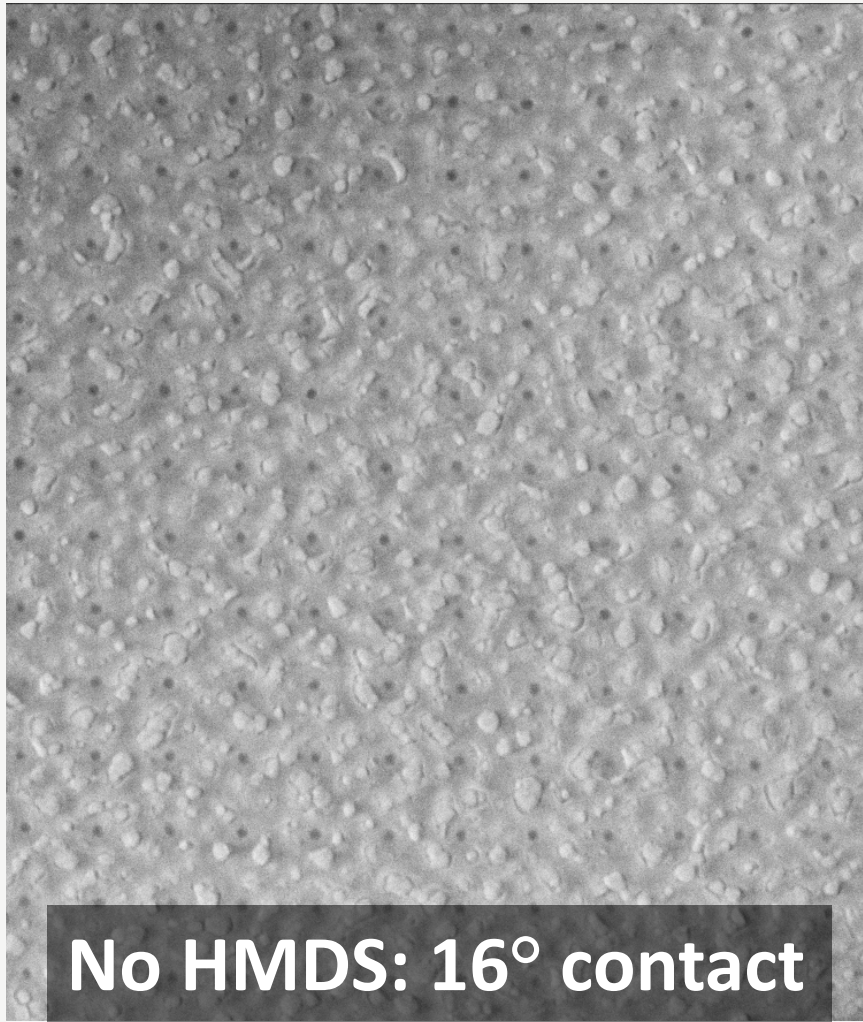
J. Doise et al., *J. Vac. Sci. Technol. B*, 2015.

TEM Images

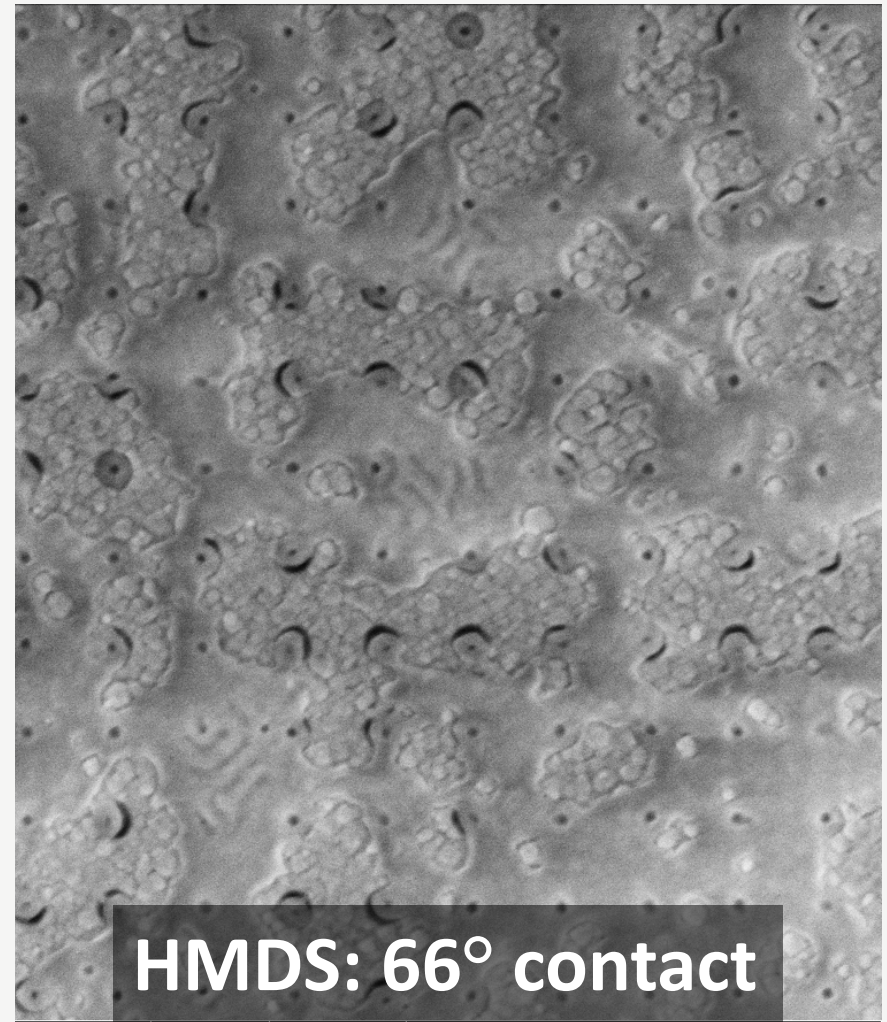


K. Okabe et al., *SPIE*, 2015.

DSA Results – SiO₂

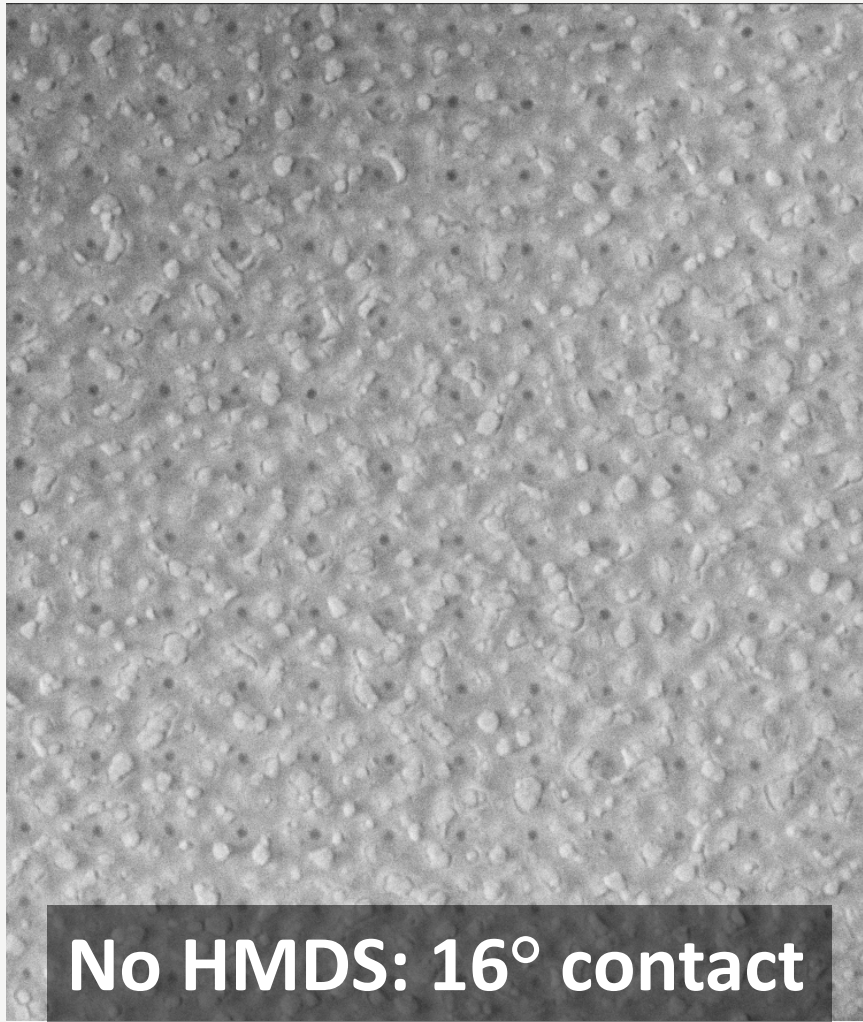


| | | | |
|----------|---------|----------|----------|
| HV | HFWD | WD | 500 nm |
| 700.00 V | 1.99 μm | 946.8 μm | Magellan |

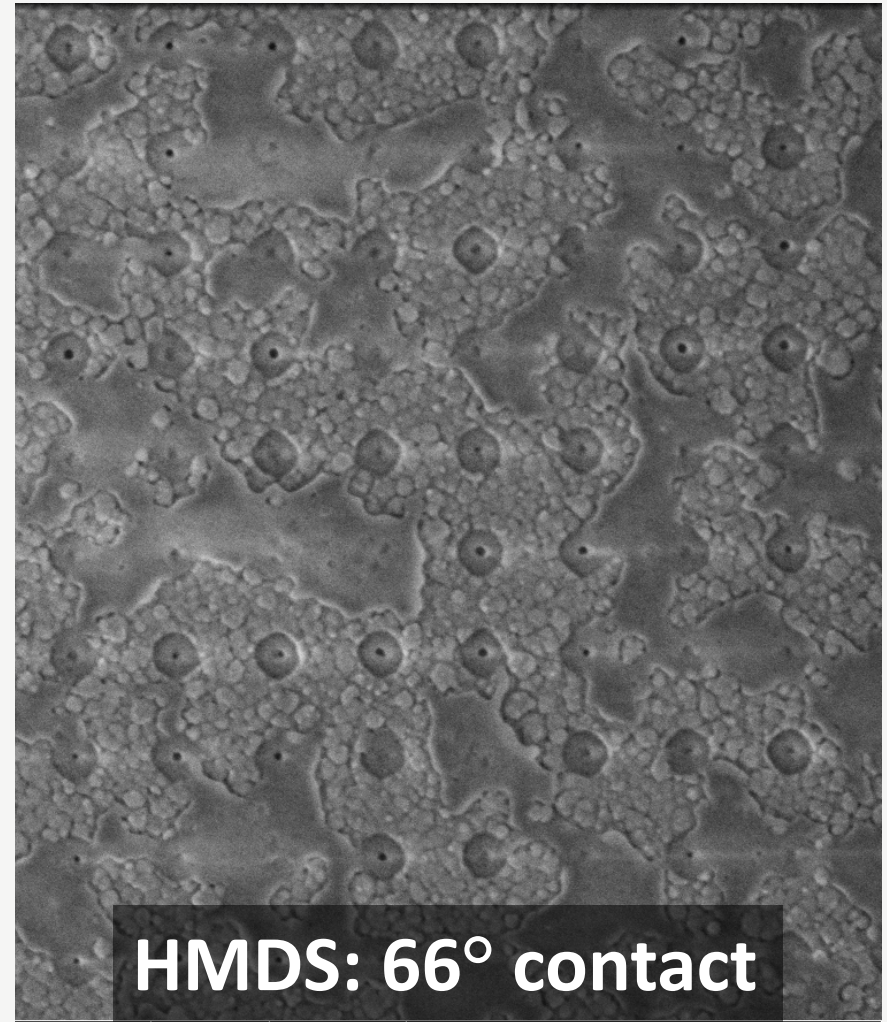


| | | | |
|----------|---------|----------|----------|
| HV | HFWD | WD | 500 nm |
| 700.00 V | 1.99 μm | 994.4 μm | Magellan |

DSA Results – SiO₂

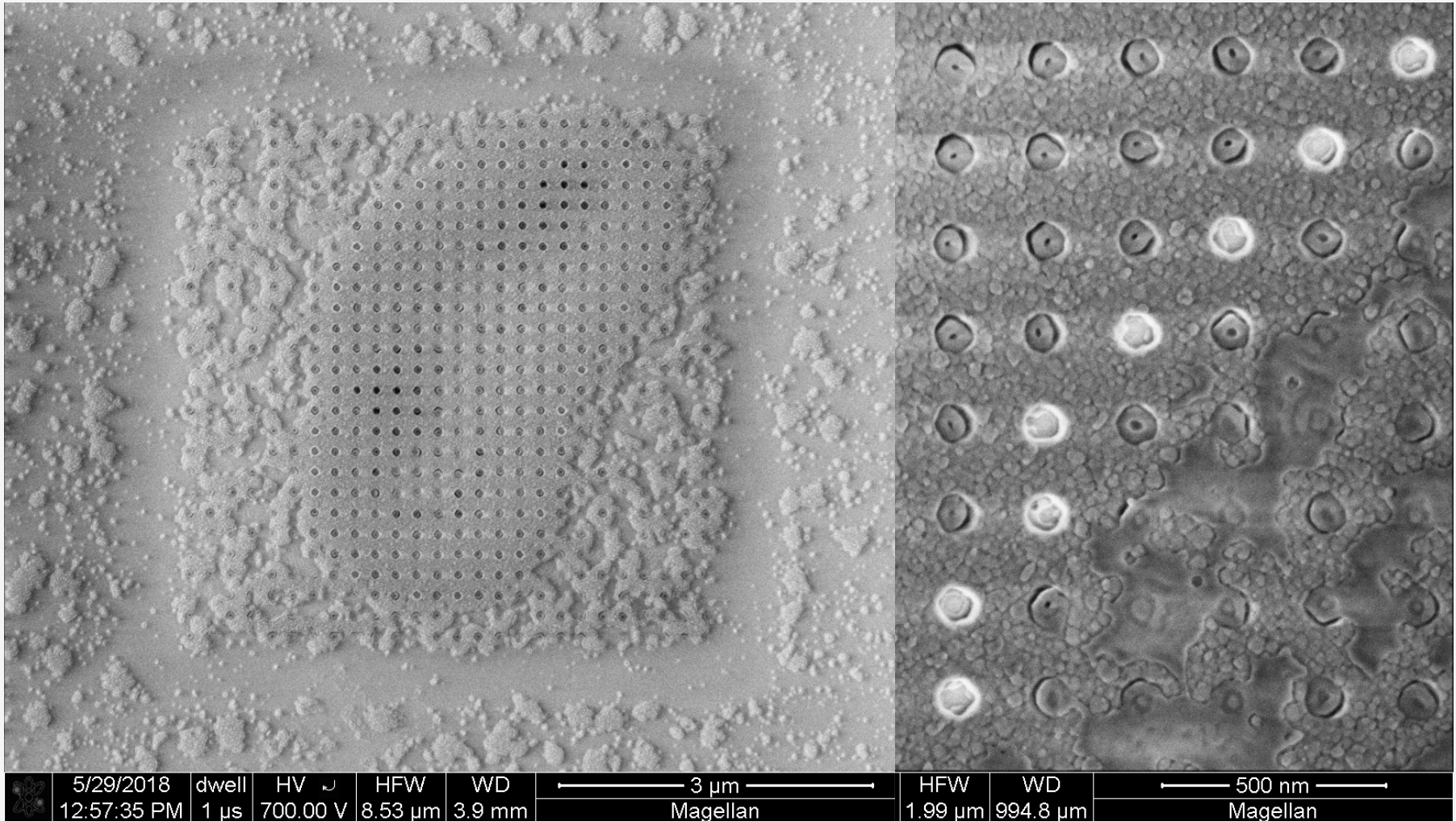


| | | | |
|----------|---------|----------|----------|
| HV | HFWD | WD | 500 nm |
| 700.00 V | 1.99 μm | 946.8 μm | Magellan |



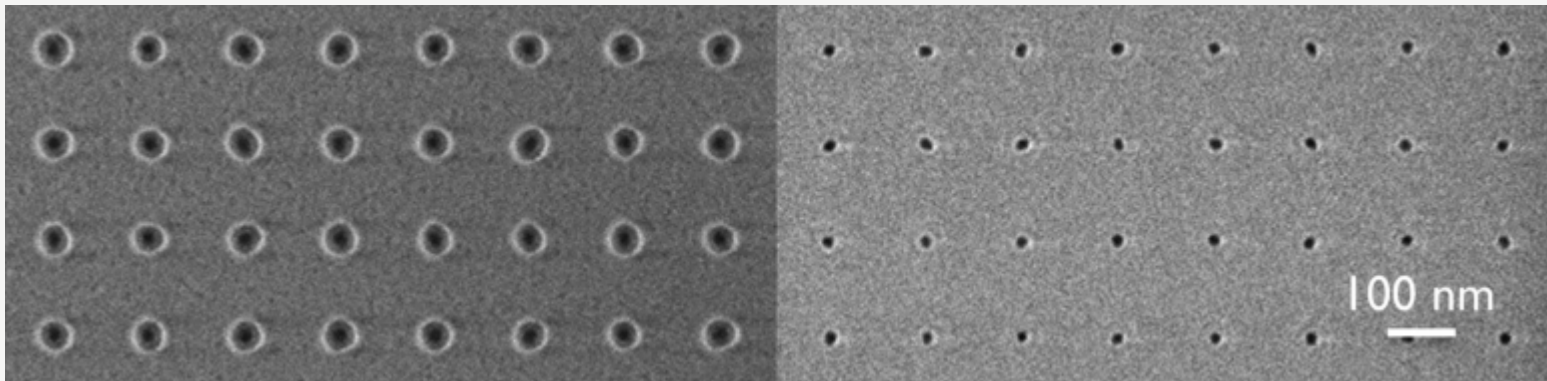
| | | | |
|----------|---------|----------|----------|
| HV | HFWD | WD | 500 nm |
| 700.00 V | 1.99 μm | 928.1 μm | Magellan |

Uneven Coating!



Conclusions + Future Work

- Success implementing a PMMA-affinitive flow using SiO_2/TiN guiding wells
- Still need to work on implementation of PS-affinitive flow
- Ultimate goal: etch the block copolymer holes!



J. Doise et al., *J. Vac. Sci. Technol. B*, 2015.