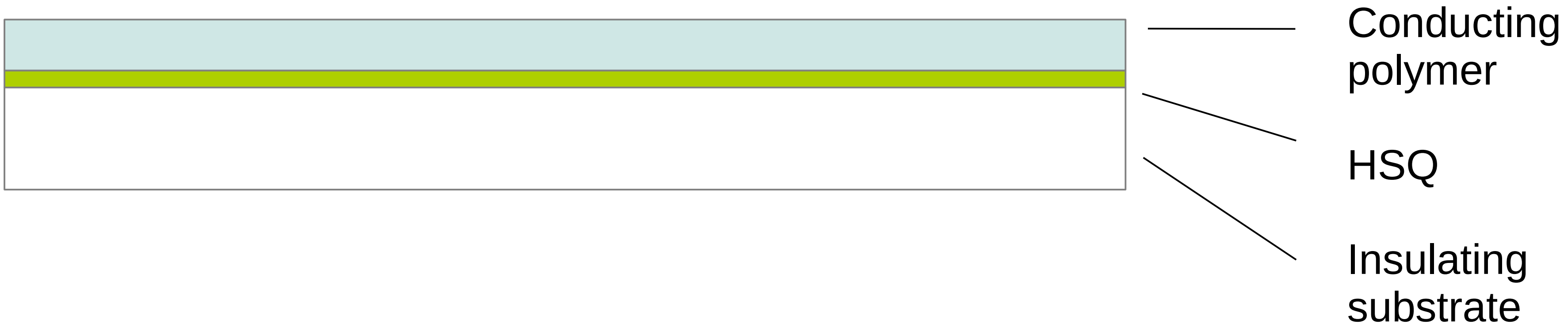
Problem: expose HSQ resist with electrons, on an insulating substrate

The usual approach does not work.
Metal deposited directly on HSQ mixes with the resist.

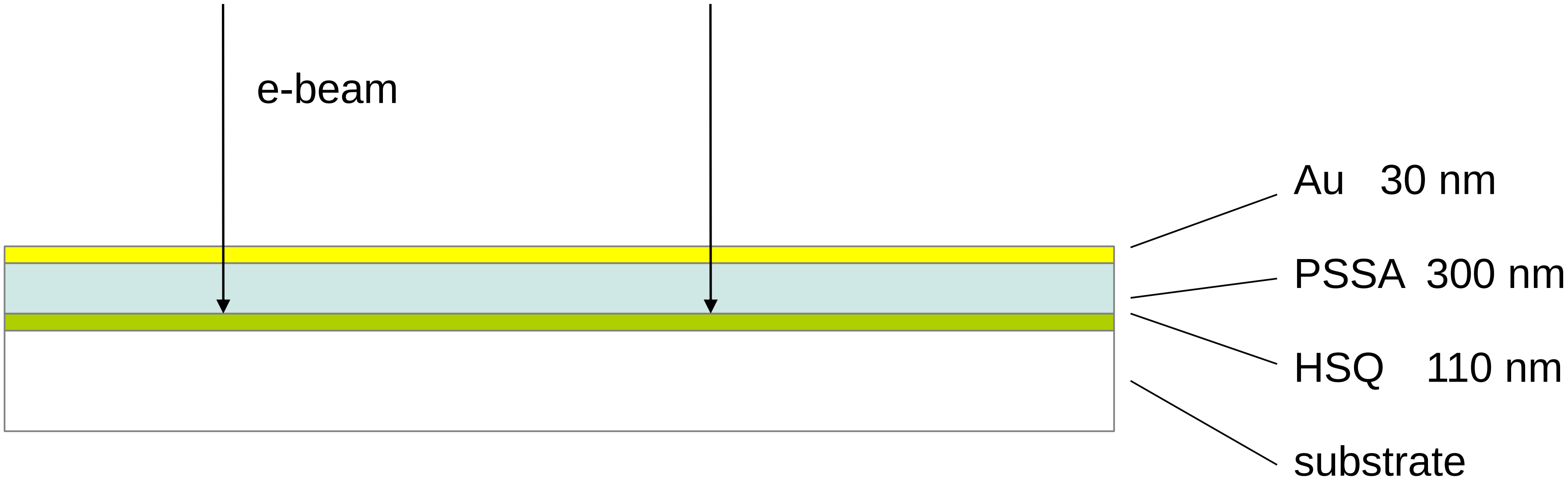
Solution: coat HSQ with a water soluble conducting polymer,
either PDOT:PSS or Espacer-300Z (Showa Denko Inc)

Next problem: conducting polymers are unstable, have short shelf-life,
and are outrageously expensive.



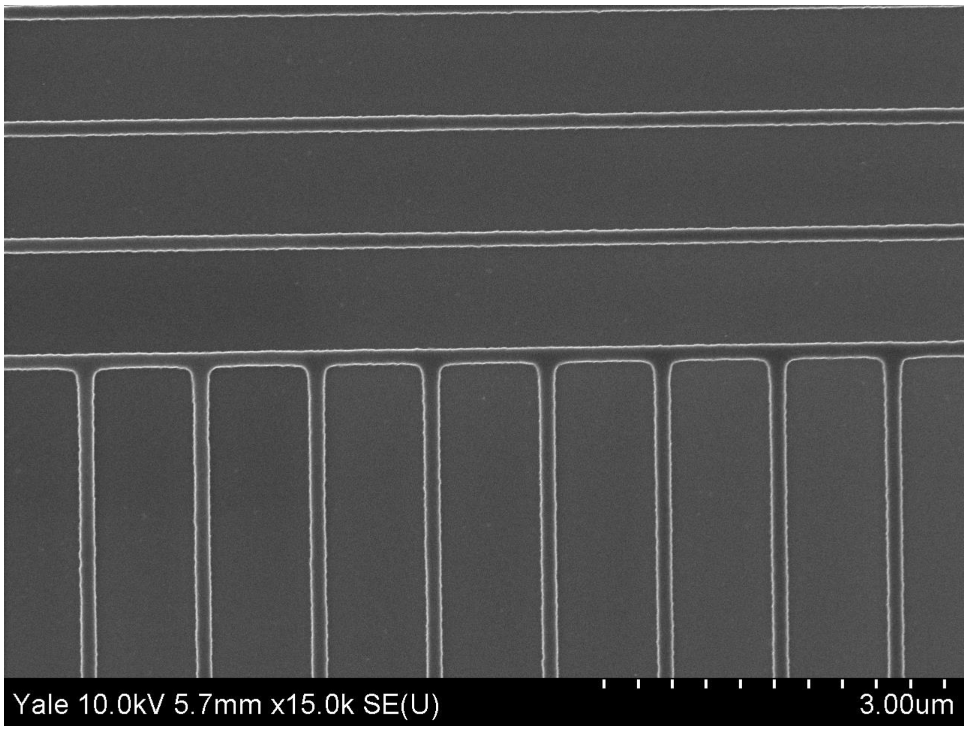
Michael Rooks, Yale University

After exposure (with electrons) but before development, strip the PSSA/metal layers in water.

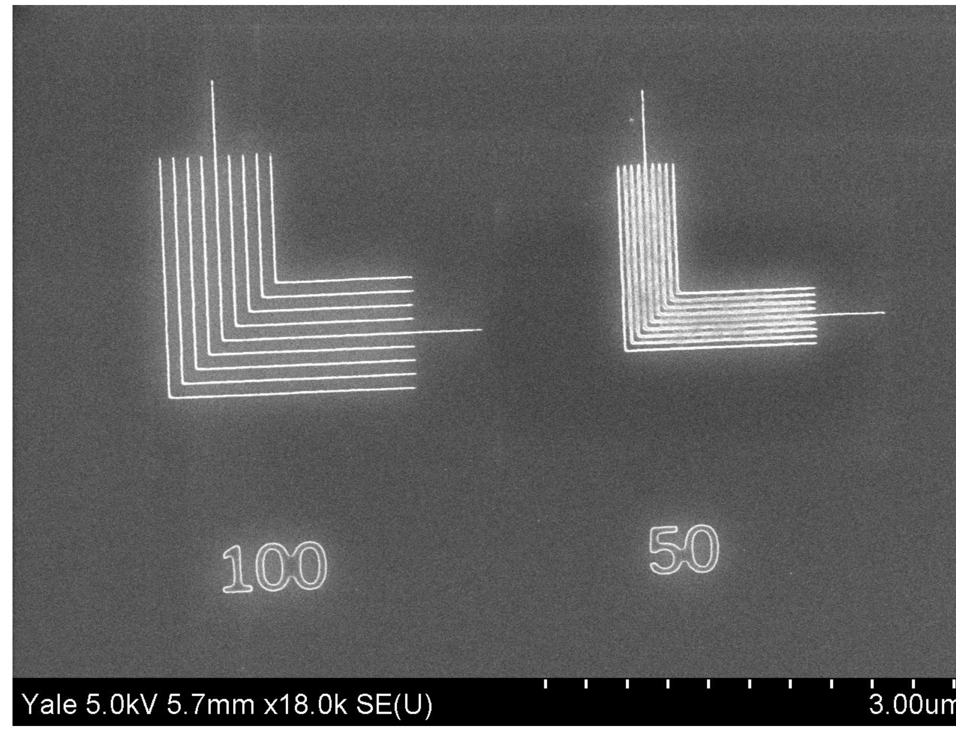


PSSA will also dissolve in developer, so the water rinse is optional.

It works.
Unexposed regions are free of residue

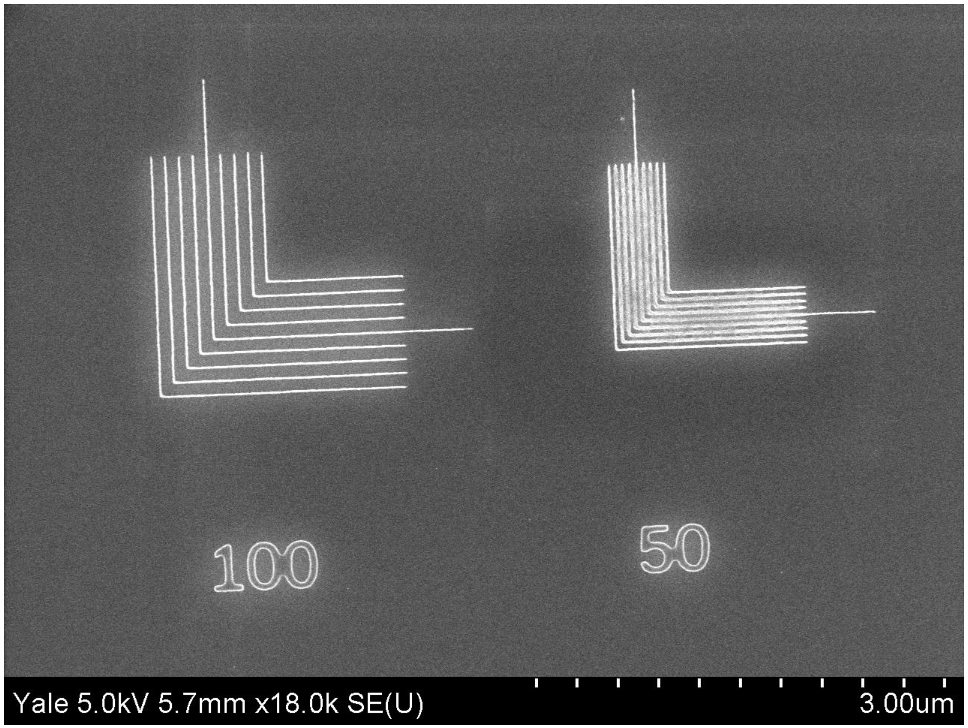


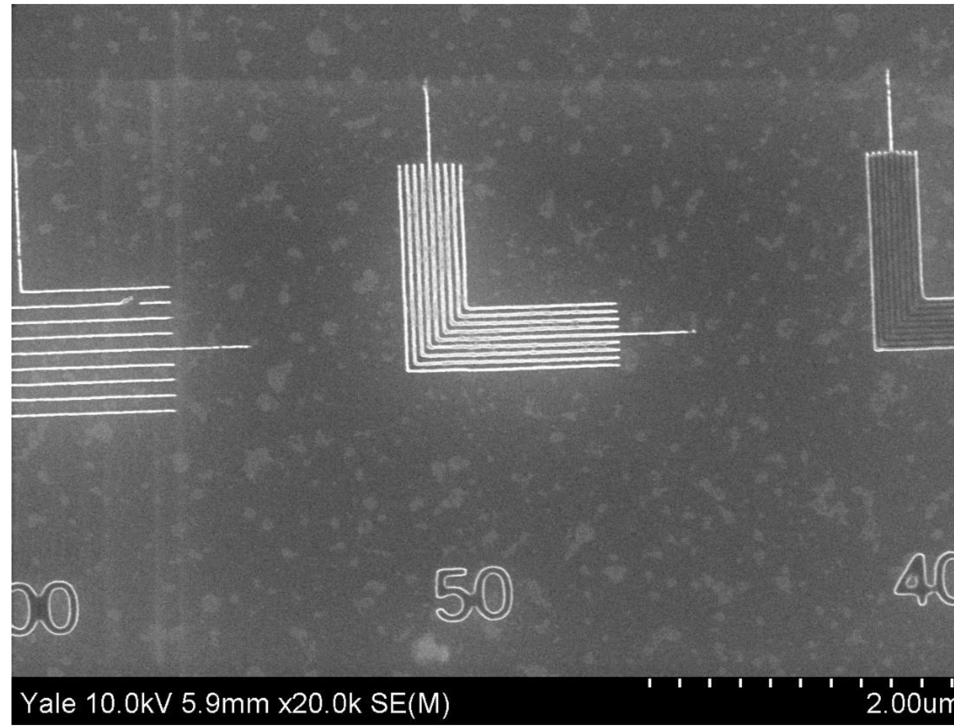
110 nm thick HSQ



30 nm thick HSQ

Watch out: Choice of surfactant is critical





PSSA surfactant:

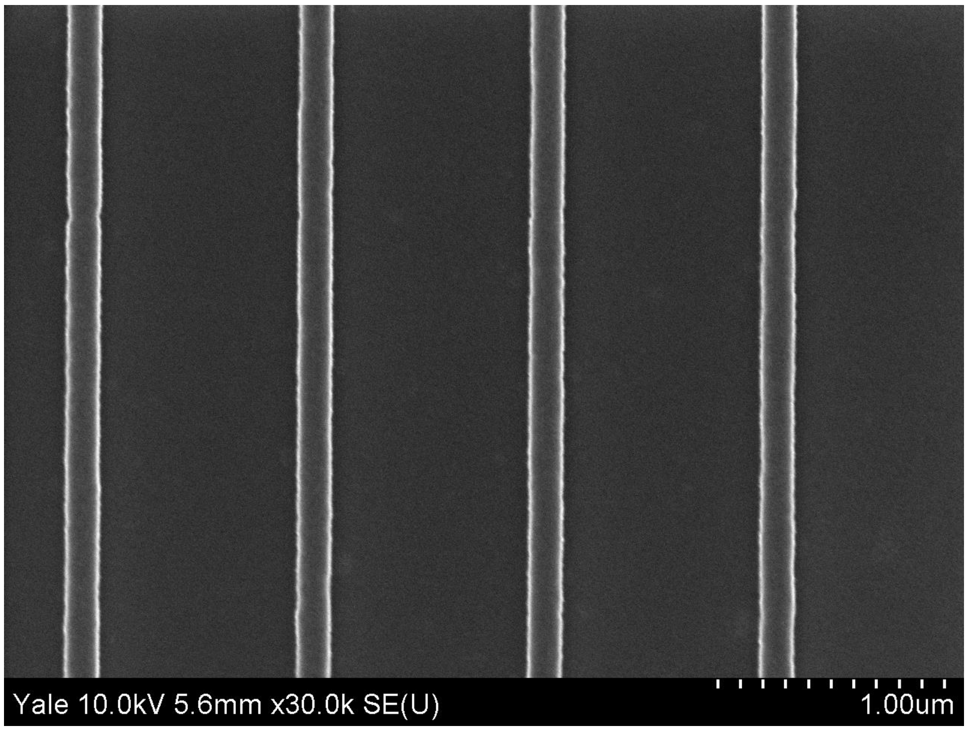
Triton X100 (1%)

3M Novec 4200

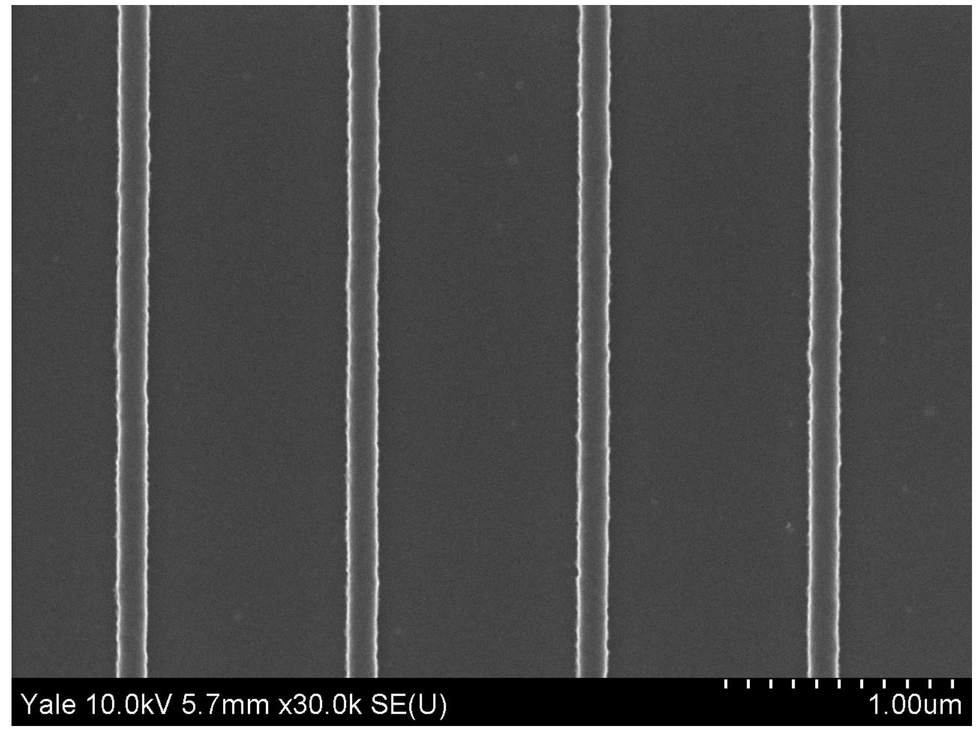
Solution is unstable

Comparison of line edge roughness

HSQ, uncoated



HSQ, previously coated with PSSA

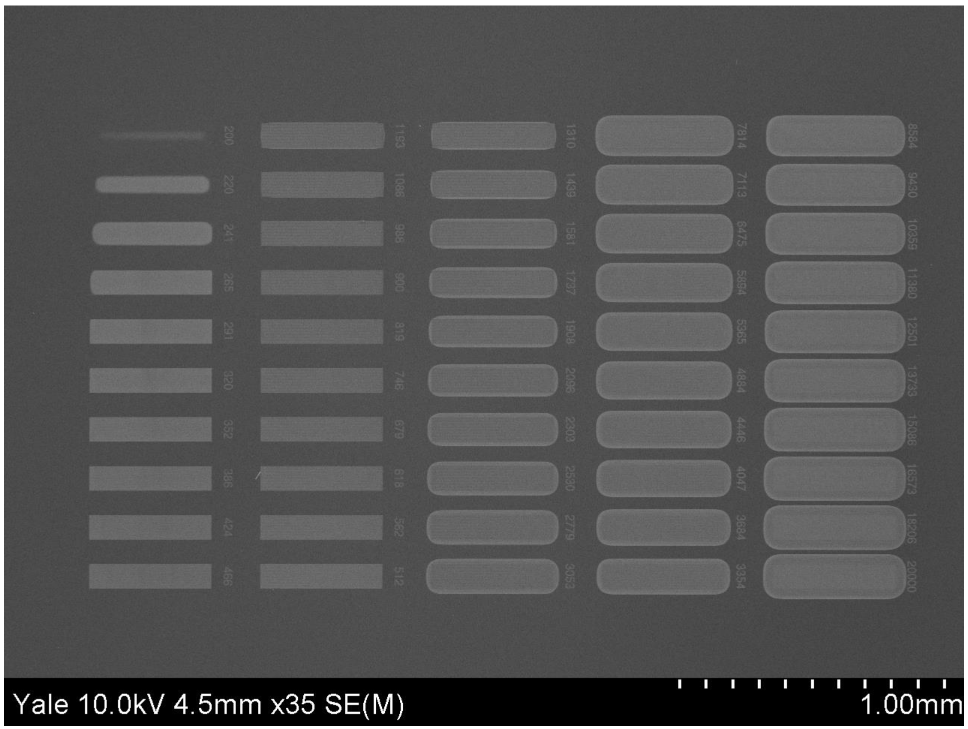


RMS roughness:	2.3 nm	2.5 nm

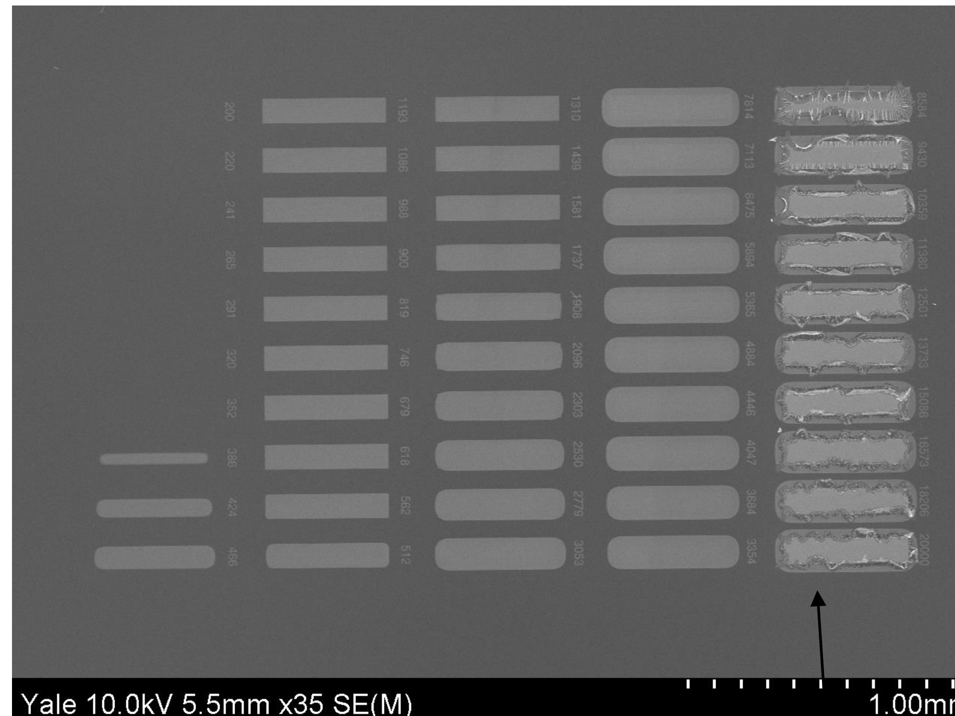
PSSA coating increases line edge roughness by 8%

Comparison of sensitivity

HSQ, uncoated



HSQ, previously coated with PSSA

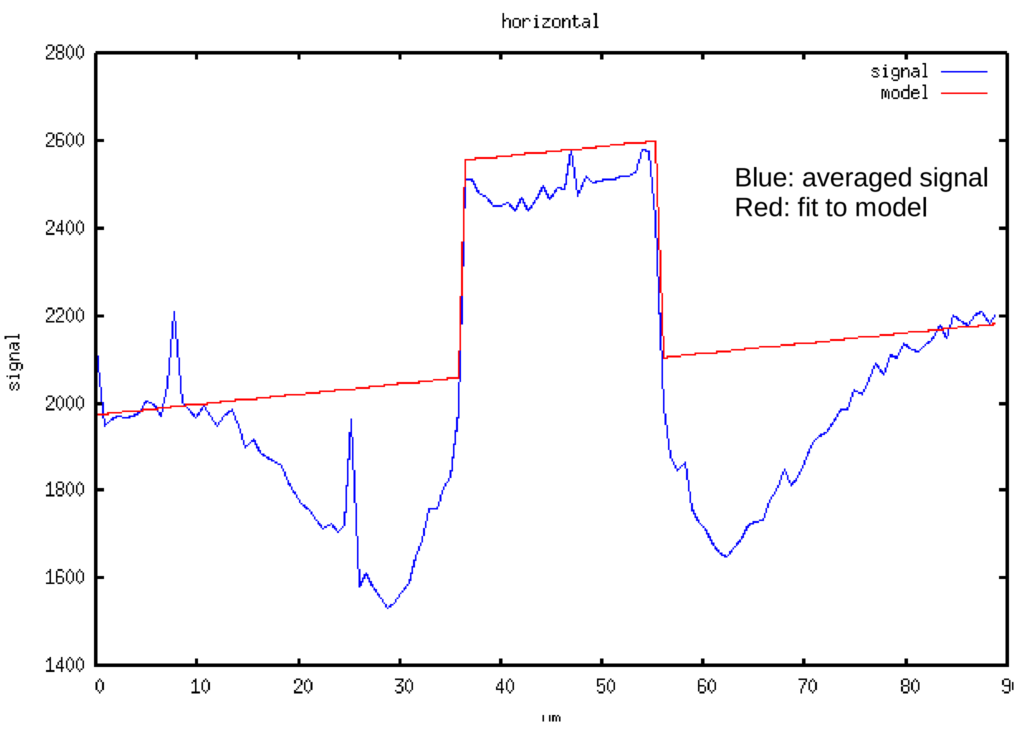


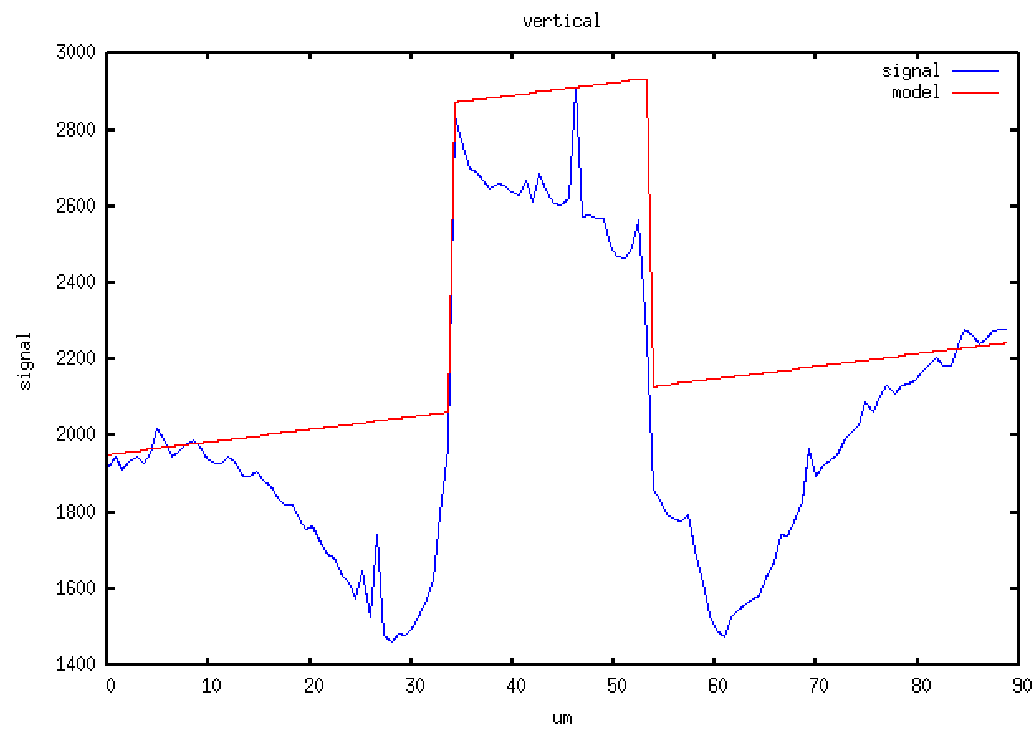
PSSA coating reduces sensitivity by a factor of ~ 2

Note metal residue at high doses

Does this work well enough for alignment?

Coarse alignment scans of a 20x20μm alignment mark (800nm thick HSQ) 50 nA, 100 kV.
Sapphire wafer coated with PSSA polymer and 20nm Au





Yes: the contrast and stability are adequate for alignment.

However, the metal will delaminate after a large exposure.
It will remain stable for one or two alignment scans, at most.

Conclusion:

Don't waste money on conducting polymers.

Instead, do it yourself with cheap PSSA polymer and Triton surfactant.