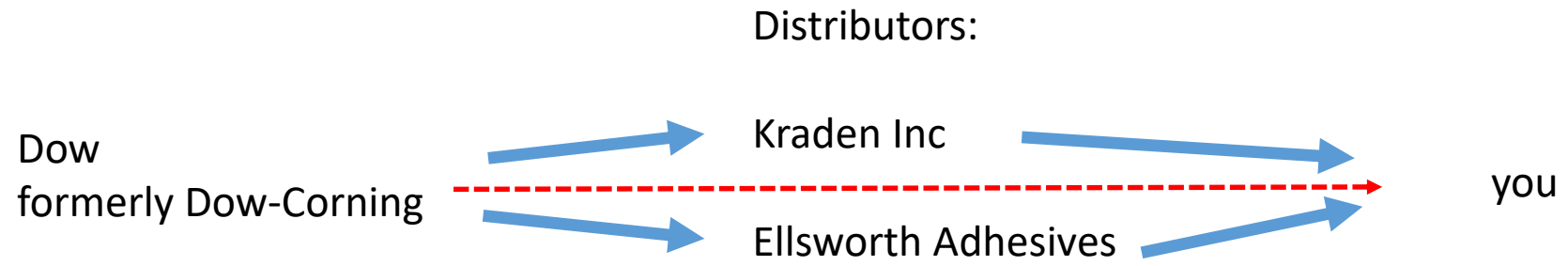


A second source for HSQ e-beam resist

M. Rooks, Yale University

Support provided entirely through Yale University. This is an unpublished trial study, not a formal experiment. Yale University does not endorse any product.

Who makes HSQ?



Comparison of Dow XR1541 6% HSQ with Dischem-AQM 5% HSQ

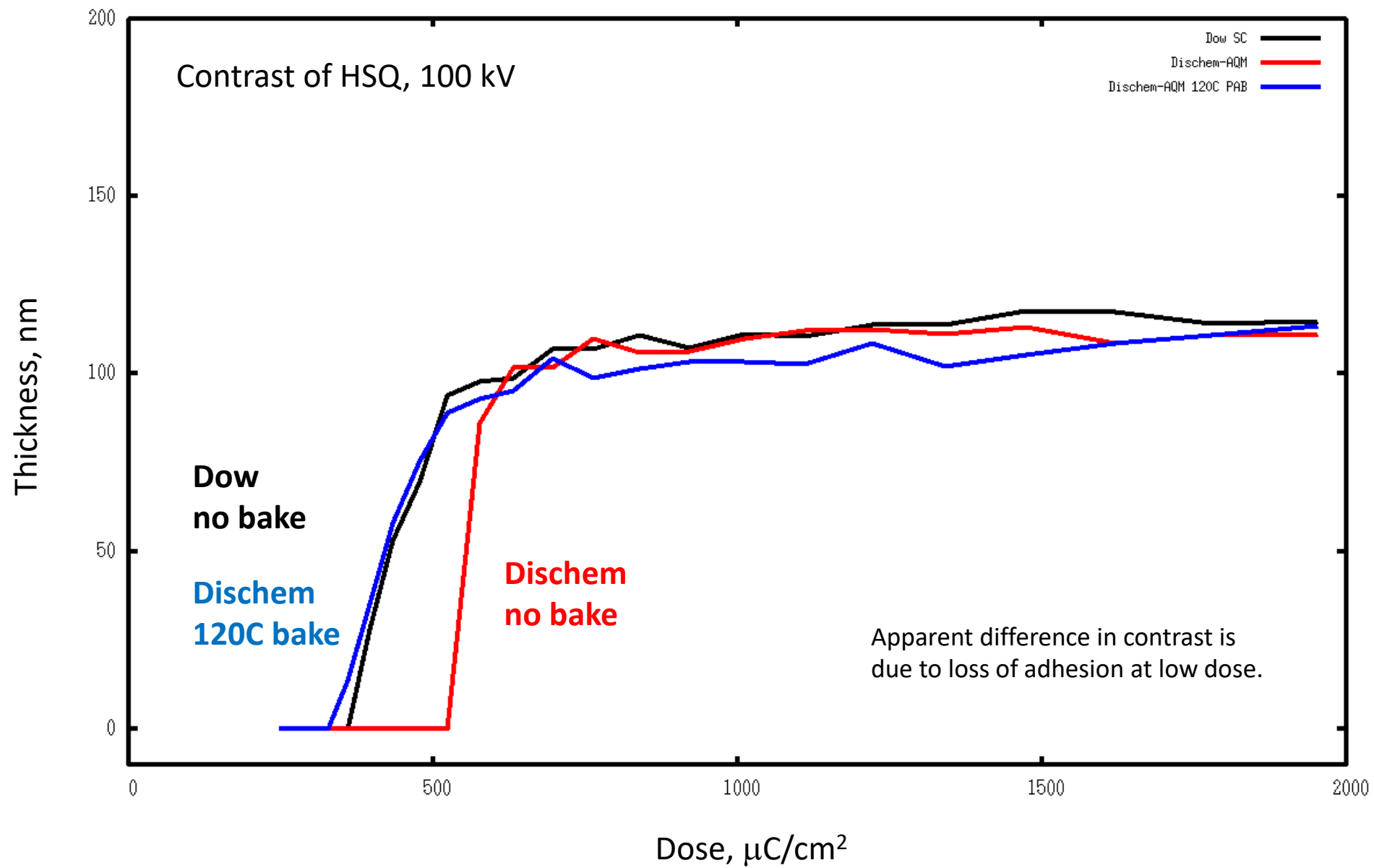
Dischem 5% HSQ was spun at 2000 rpm for ~ 100 nm thick film.
Dow 6% HSQ was spun at 3000 rpm, to provide roughly the same thickness

Both resists were spun on bare silicon (with a native oxide) with no cleaning or surface preparation.

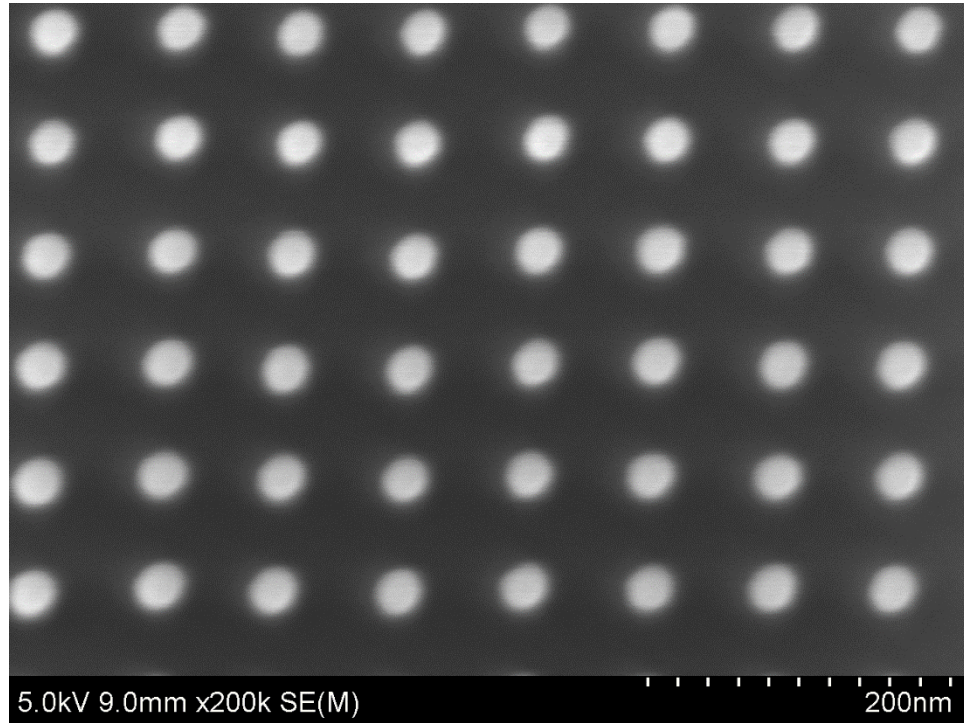
Dow HSQ was spun and dried at room temperature, which is our standard procedure.
Dischem HSQ was dried at room temperature also, and a second wafer was baked (“post apply baked”) at 120C.*

Exposure tests were run at 100 kV on a Raith EBPG.
Wafers were developed in MF312 (TMAH, 0.54N) for 4 minutes.

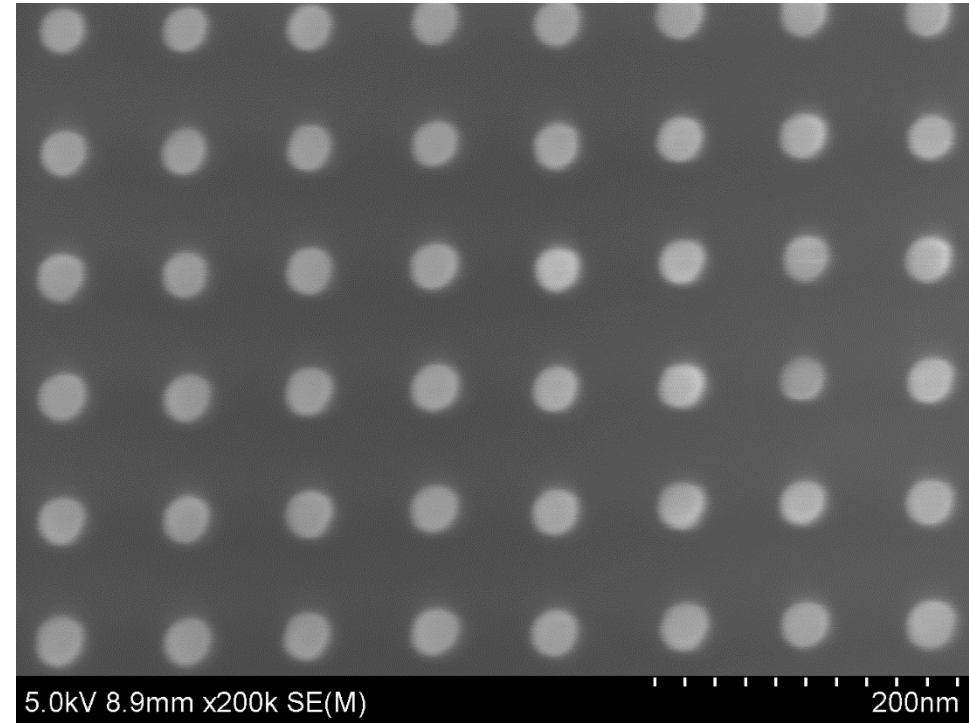
* 120C was chosen as the post-apply bake because we had a hotplate already set to that temperature. Other temperatures probably also work, but we did not try them.



Dow 6% HSQ

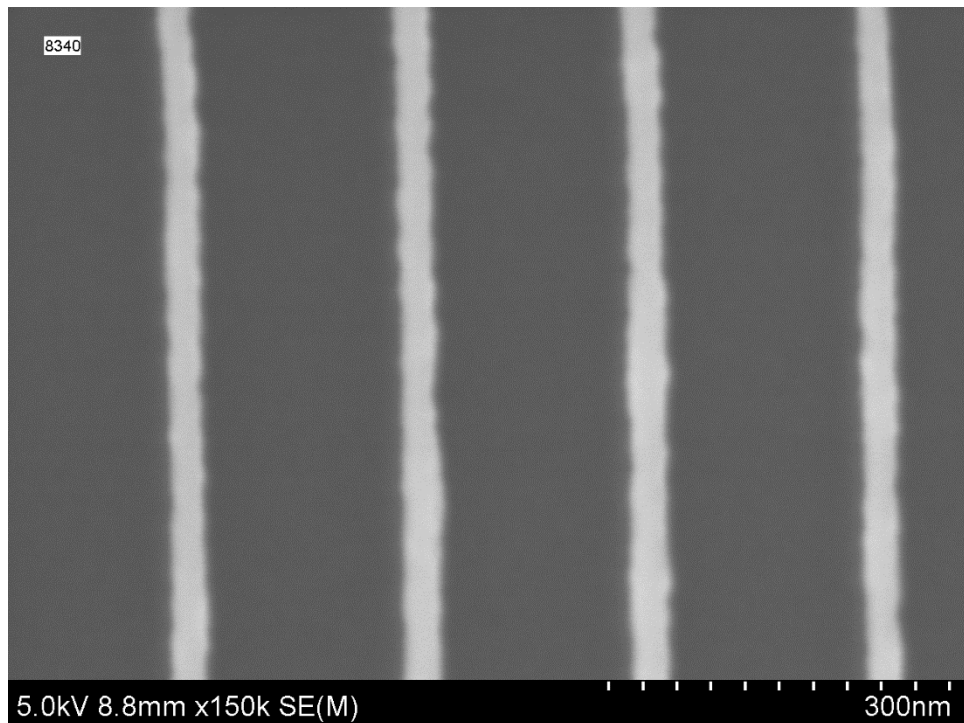


Dischem-AQM 5% HSQ



Single-pixel dots, no blanking

Dow 6% HSQ



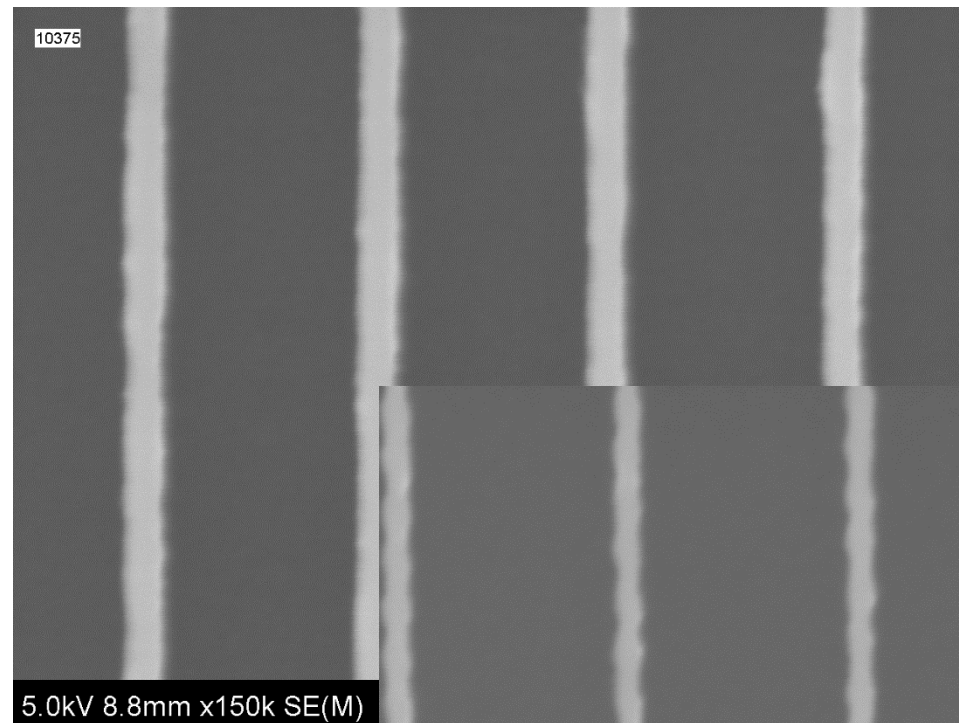
8 mC/cm²

Single-pass lines

bss=10nm

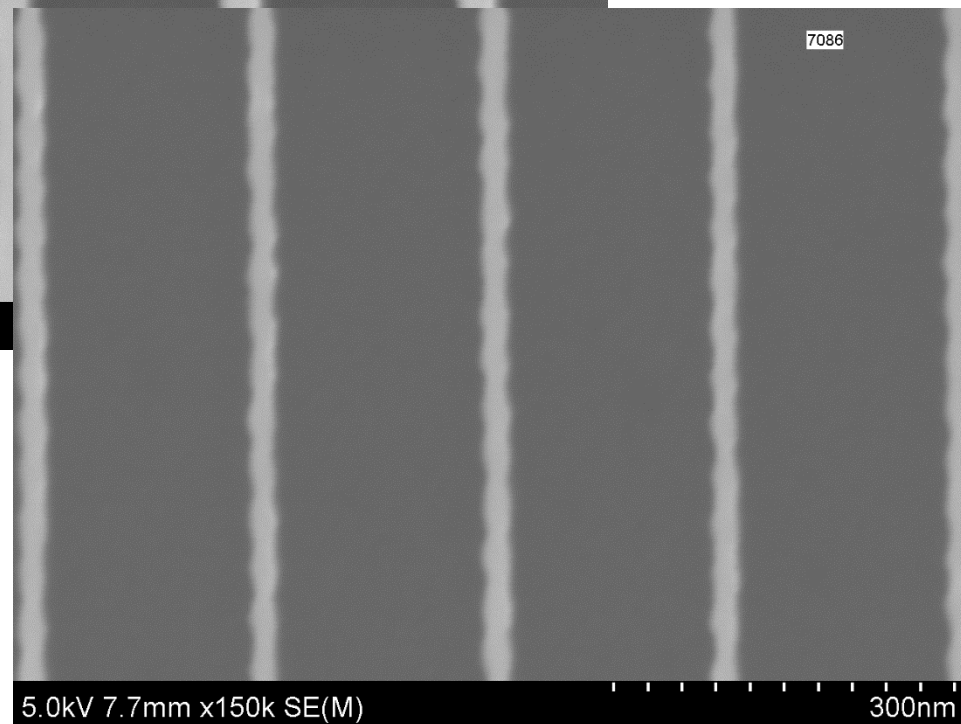
Note ~ 3:1 aspect ratio

Dischem-AQM 5% HSQ



10 mC/cm²

7 mC/cm²



864

Dow 6% HSQ

5.0kV 8.9mm x2.50k SE(M)

20.0um

Dischem-AQM 5% HSQ

5.0kV 8.8mm x2.50k SE(M)

20.0um

1792

1792 $\mu\text{C}/\text{cm}^2$

5.0kV 8.8mm x10.0k SE(M)

5.00um

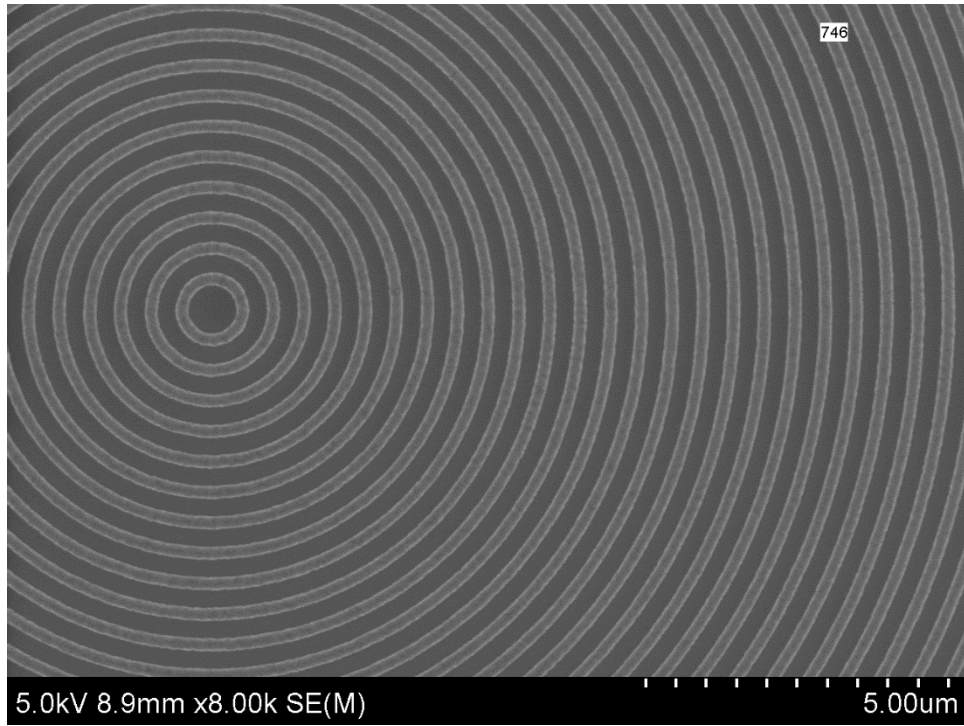
1440

1440 $\mu\text{C}/\text{cm}^2$

5.0kV 7.8mm x10.0k SE(M)

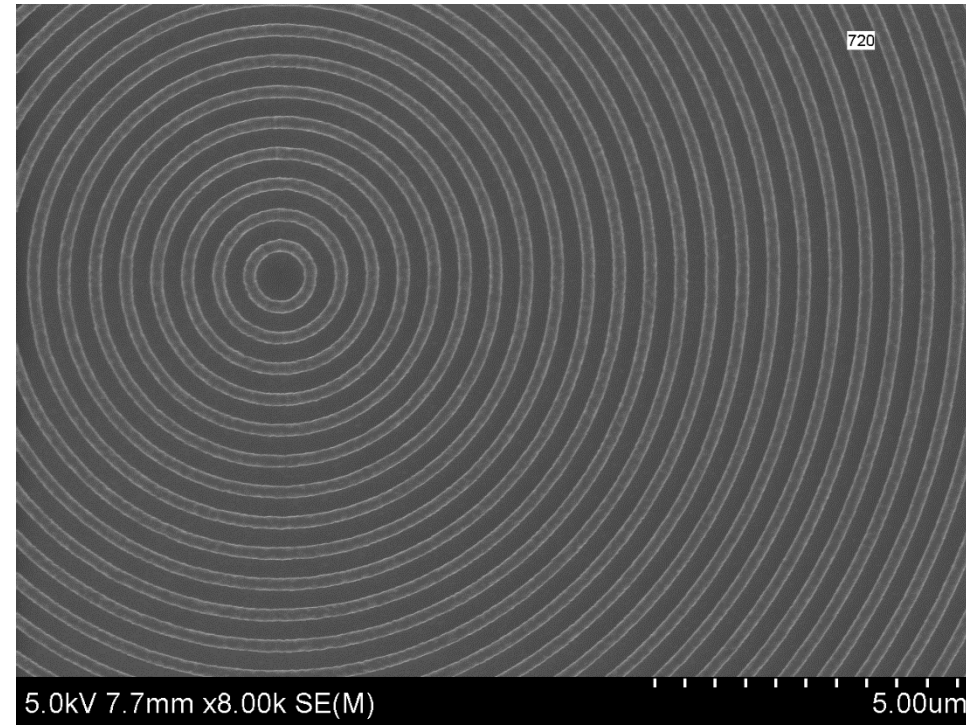
5.00um

Dow 6% HSQ



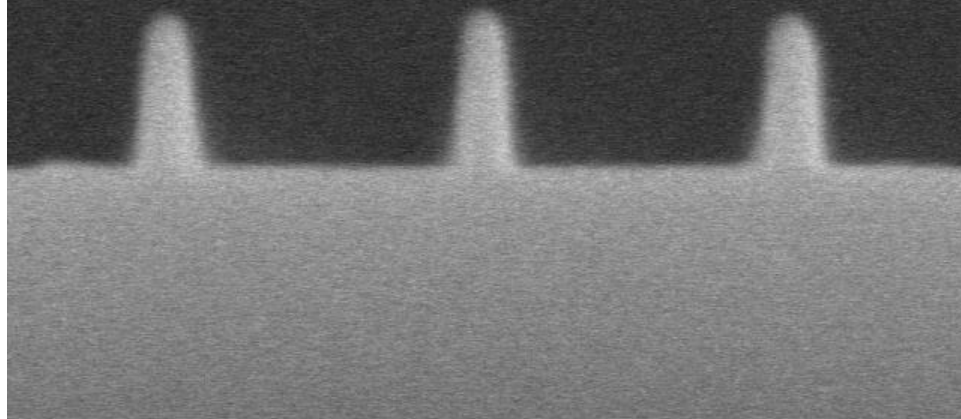
746 $\mu\text{C}/\text{cm}^2$

Dischem-AQM 5% HSQ

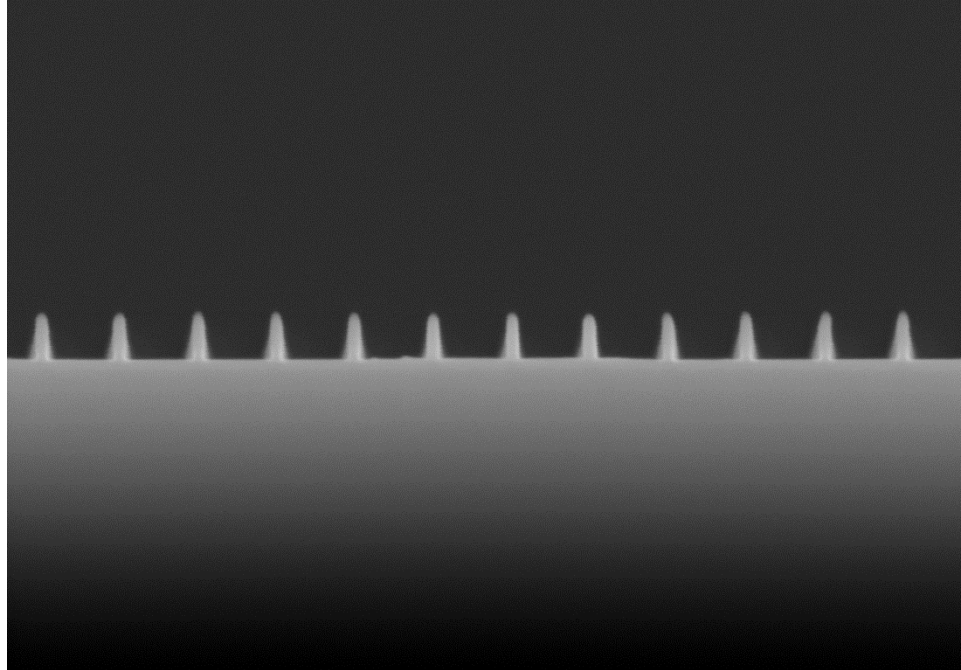


720 $\mu\text{C}/\text{cm}^2$

Dow 6% HSQ

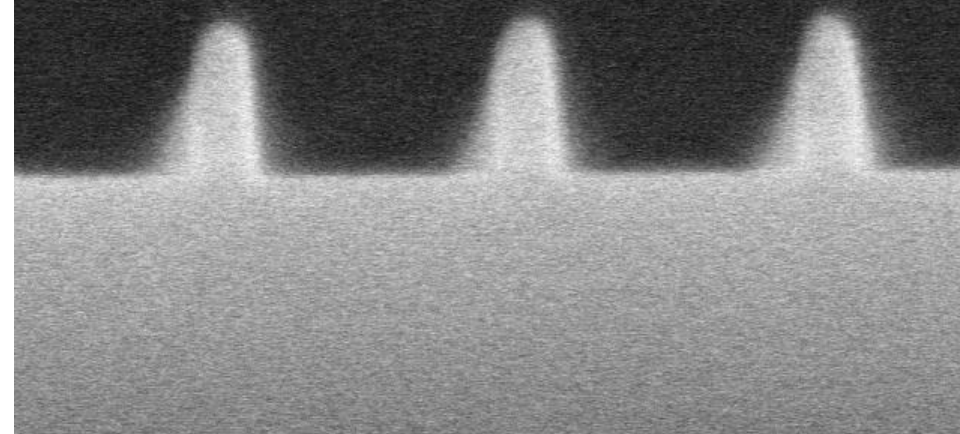


10.0kV 15.2mm x200k SE(M) 200nm

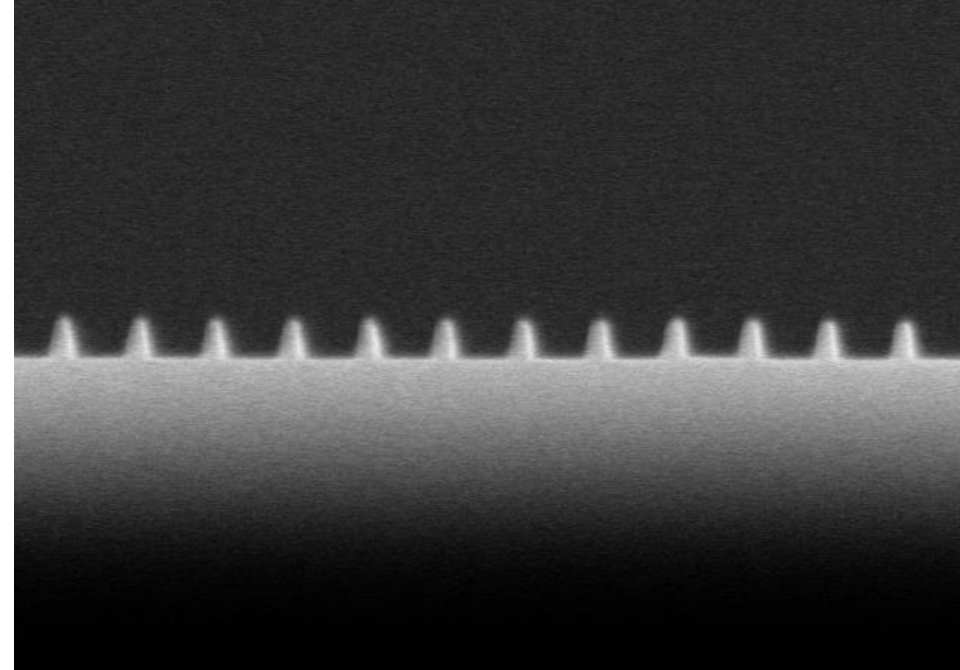


10.0kV 15.2mm x50.0k SE(M) 1.00um

Dischem-AQM 5% HSQ



10.0kV 14.3mm x200k SE(M) 200nm



10.0kV 14.3mm x50.0k SE(M) 1.00um

Dischem-AQM HSQ demonstrates resolution and smoothness very similar to that of Dow HSQ.

Dischem HSQ requires 30-40% higher dose when dried at room temperature, and requires roughly the same dose as Dow HSQ when baked at 120C.

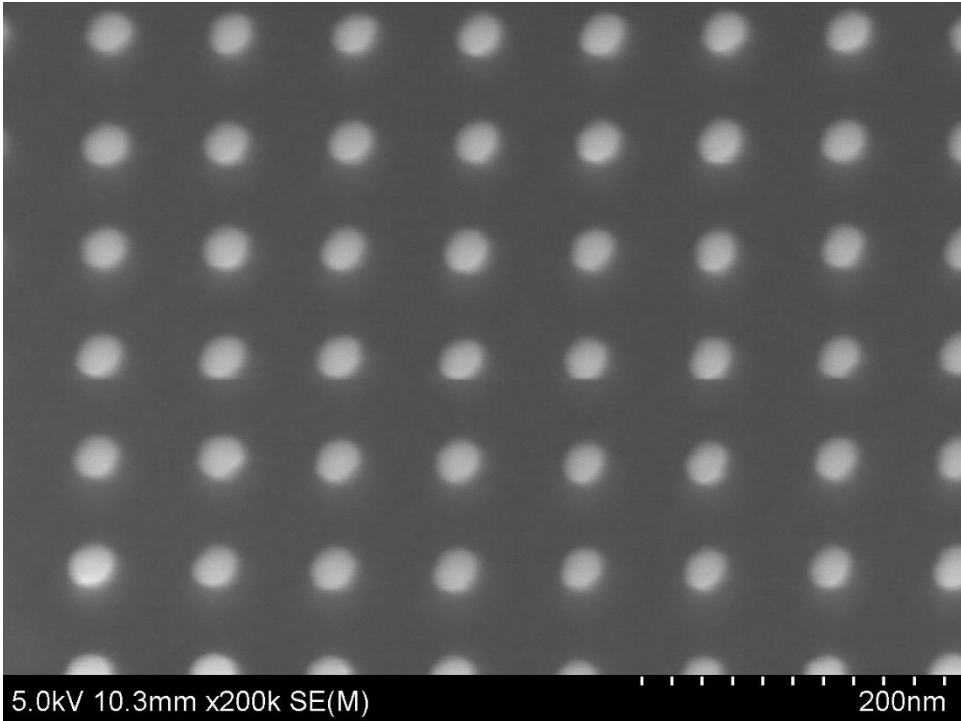
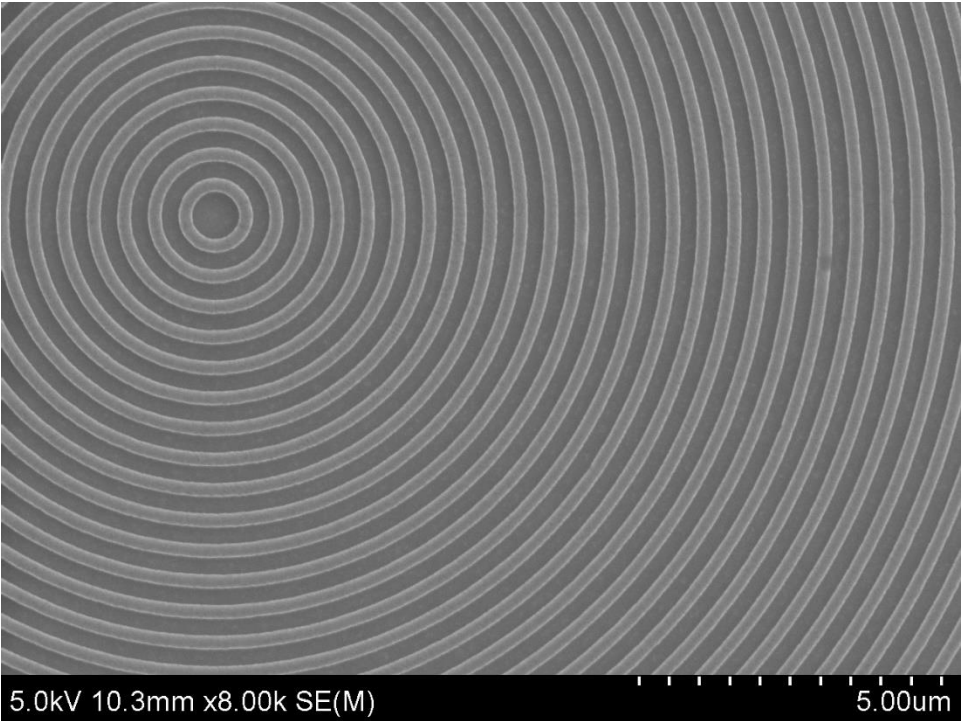
Qualitatively, it appears that unbaked Dischem HSQ loses adhesion at low doses. Therefore it would be incorrect to calculate a higher contrast based on the thickness plot. Baking Dischem HSQ at 120C for 2 minutes improves adhesion.

The contrast/sensitivity of Dischem HSQ baked at 120C (2 min) is identical to that of Dow HSQ with no post-apply bake.

Etch resistance in CF₄ was identical:

30 sccm CF₄
30 mTorr
100 W
33 nm/min

First production run of 6% Dischem HSiQ looks the same as the free sample



Filtered with a 0.22um syringe,
120C post-apply bake,
developed 4 min in MF312 (TMAH)

Summary

Dischem HSQ is a drop-in replacement for Dow HSQ, with only a minor change to the post-apply bake.

EM Resist LTD also sells HSQ (which we did not test) and so we have potentially three vendors.

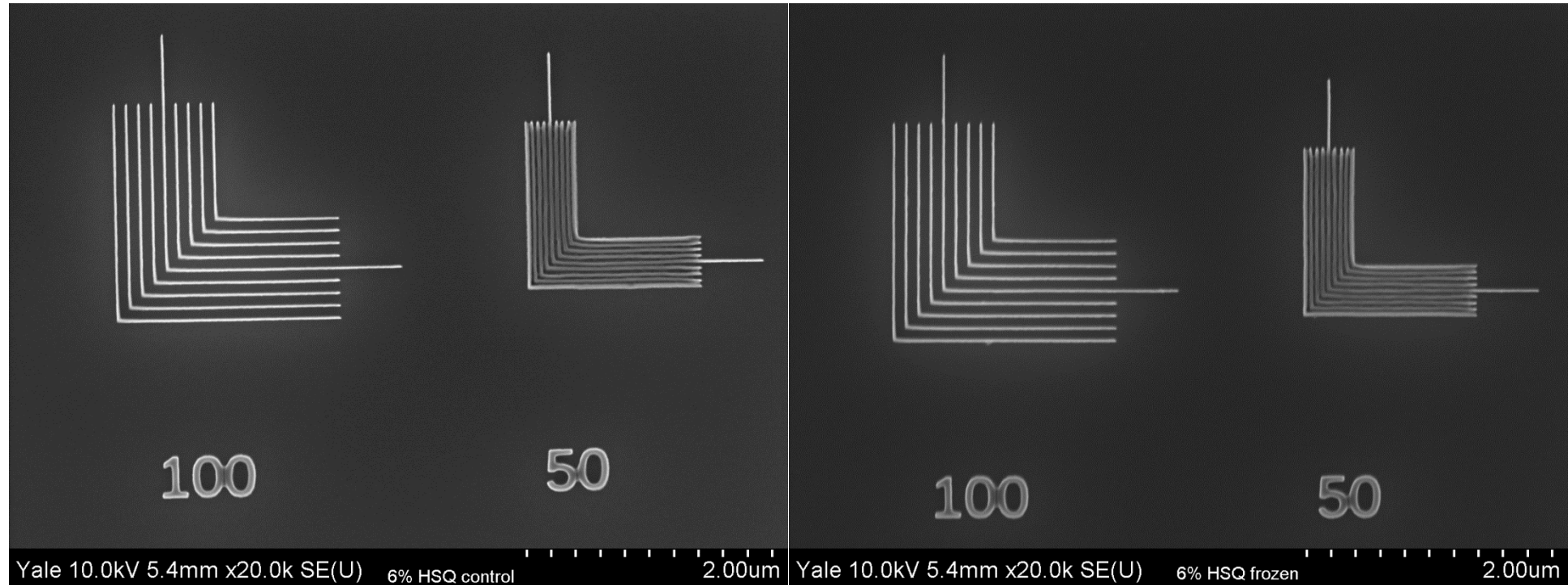
Dischem and EM Resist do not sell 800nm thick “FOX-16” solutions, but one can substitute a two-layer process using thin HSQ and a polymer.

Let's not forget that...

You Can Freeze HSQ

HSQ stored as liquid, -27°C

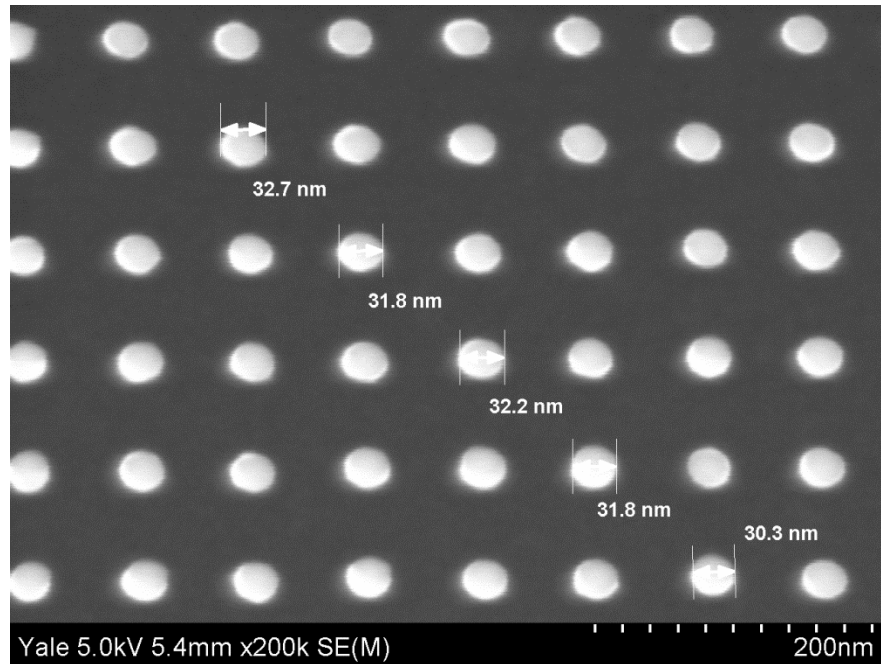
Stored frozen at -196°C (liquid nitrogen)



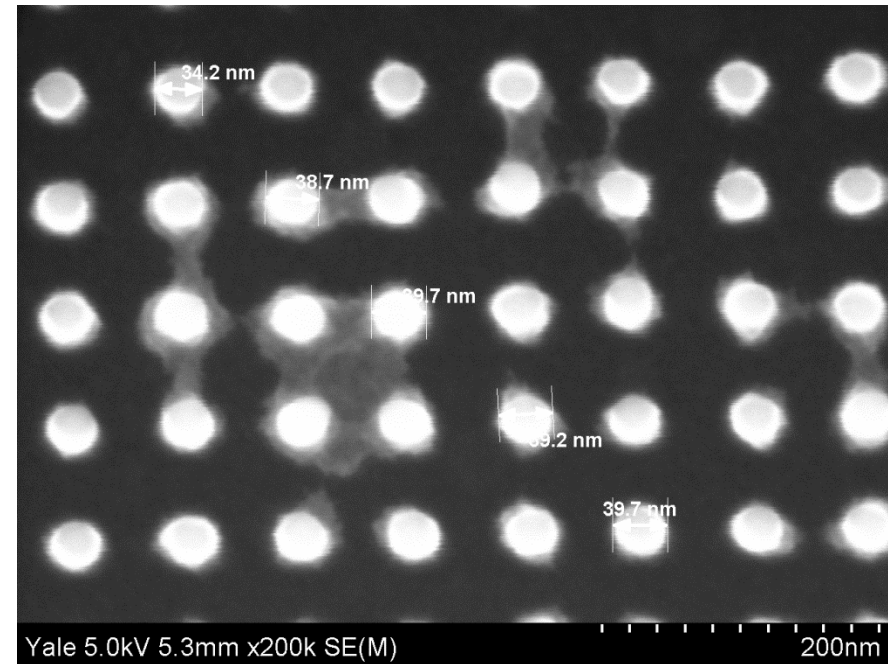
Freezing HSQ has no effect

Freezing point of MIBK = -85°C

Frozen at 77°K 12 months



Liquid at -27°C for 12 months

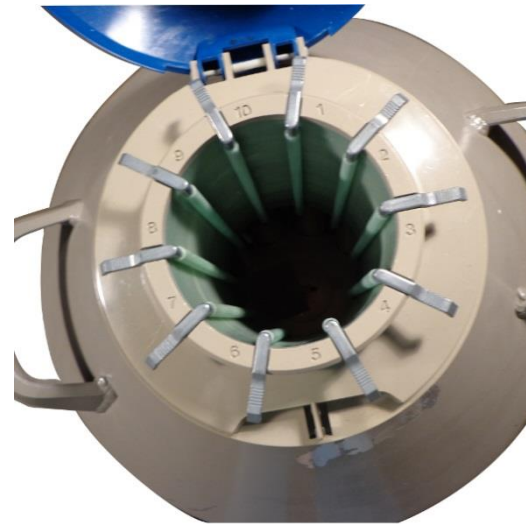


When HSQ goes bad, the first sign is a drop in dose (increased sensitivity).
Also, scum between features becomes more pronounced.

HSQ shelf life is ~ 9 months when stored at -27°C

HSQ shelf life at 77°K is indefinite.

Liquid nitrogen storage units are relatively inexpensive.



\$751 from Amazon

Uses < 0.5 liter/day
= 0.16 \$/day



4 ml HDPE bottles
VWR cat. #414004-151

Dispense the resist into 4 ml bottles
then warm them up one at a time.