

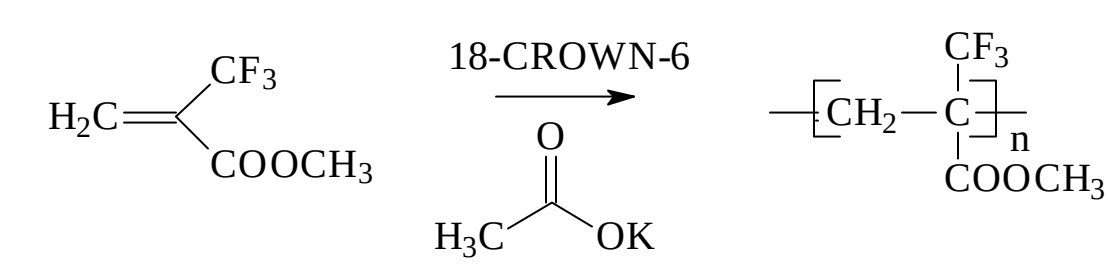
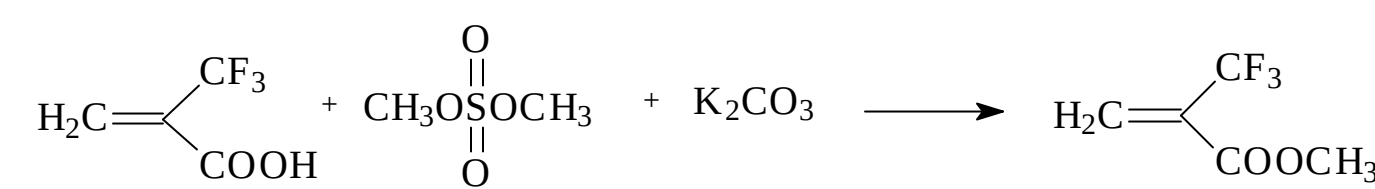
Poly[2-(Trifluoromethyl) Acrylates] for 157 nm Applications



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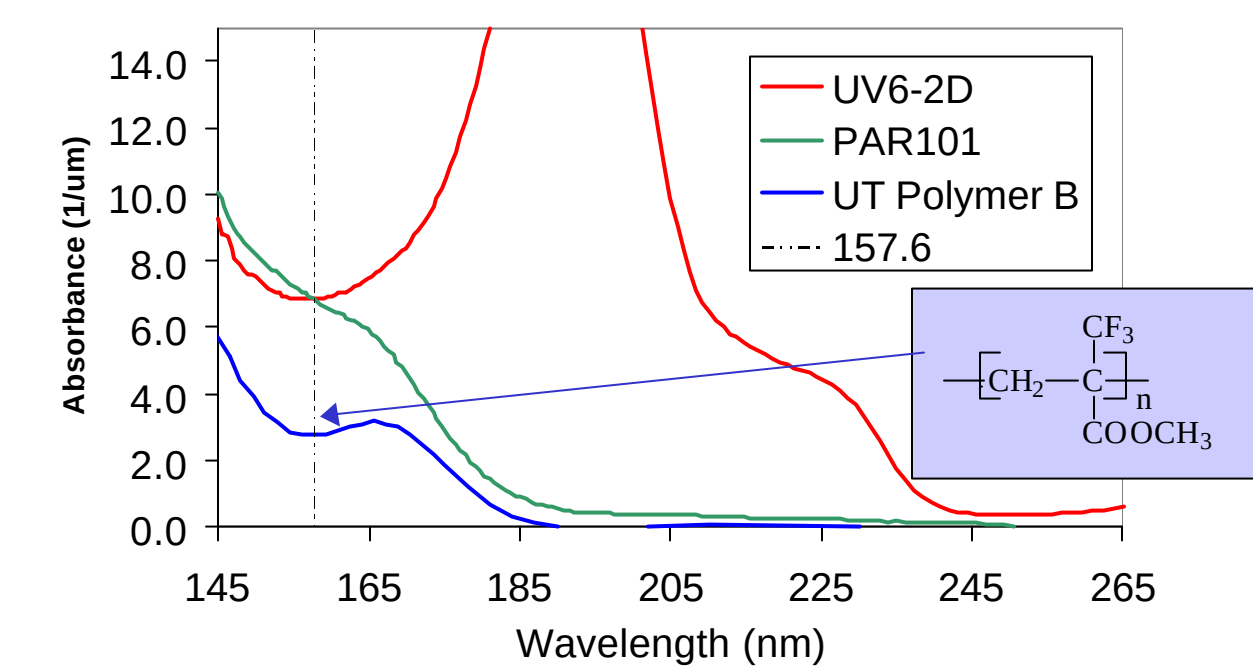


Poly[Methyl 2-(Trifluoromethyl) acrylate]



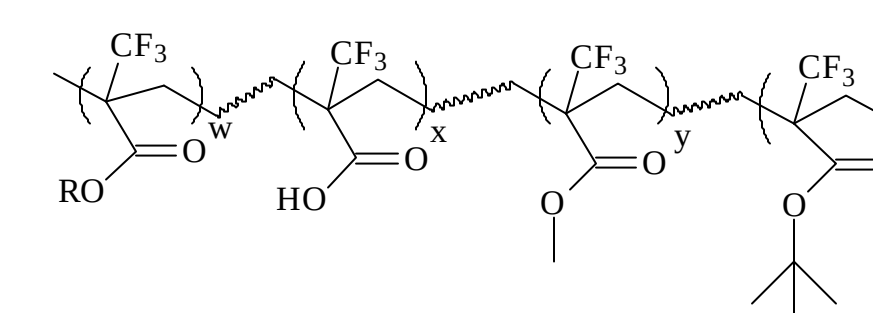
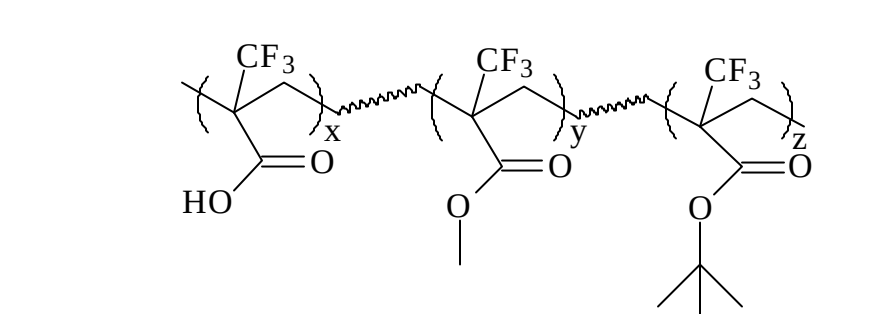
- Polymer was studied in the early 80s as an e-beam resist
 - Ito, H., Miller, D.C., Willson, C.G., *Macromolecules*, **15**(3), 915-920 (1982).
 - Interesting weak base initiated anionic polymerization

VASE Measurements



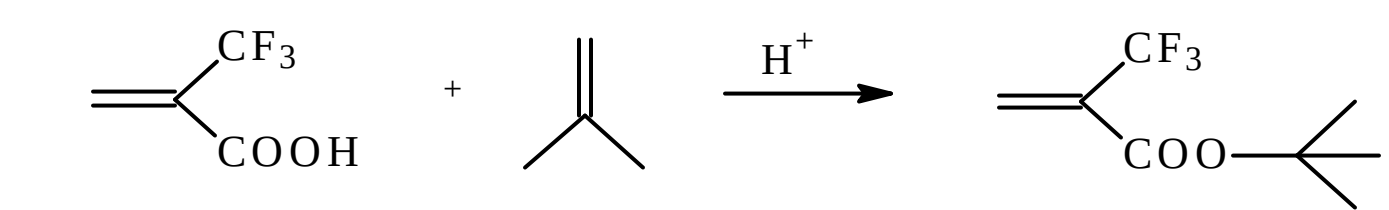
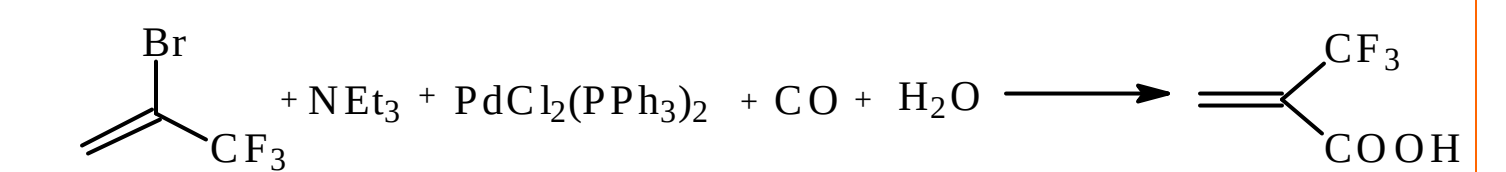
- UT Polymer B: $2.8 \mu\text{m}^{-1}$
 - T. Chiba, R.J. Hung, S. Yamada, B. Trinque, M. Yamachika, C. Brodsky, K. Patterson, A. V. Heydon, A. Jamison, S. H. Lin, M. Somervell, J. Beyers, W. Conley, and C. G. Willson, *J. Photopolym. Sci. Technol.* 13 (2000) 657-664

Goal: 157 Resist Analogues of IBM 193 Resists



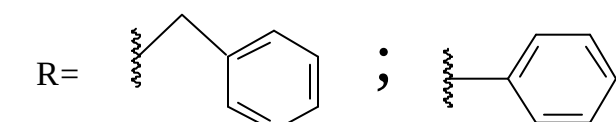
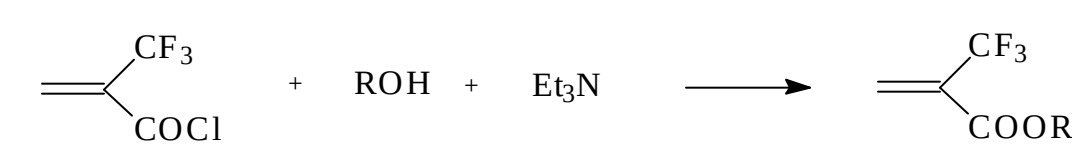
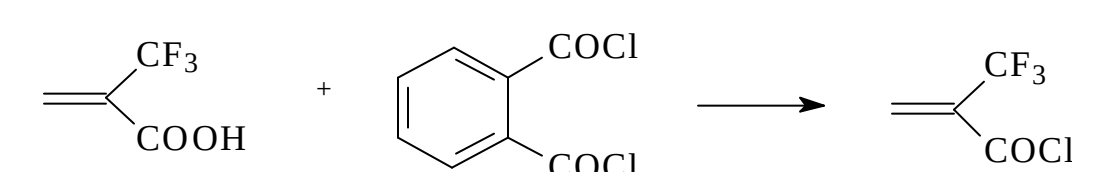
R = Fluorinated alicyclic unit
for etch-resistance

2-(Trifluoromethyl) Acrylic Acid and *t*-Butyl Ester



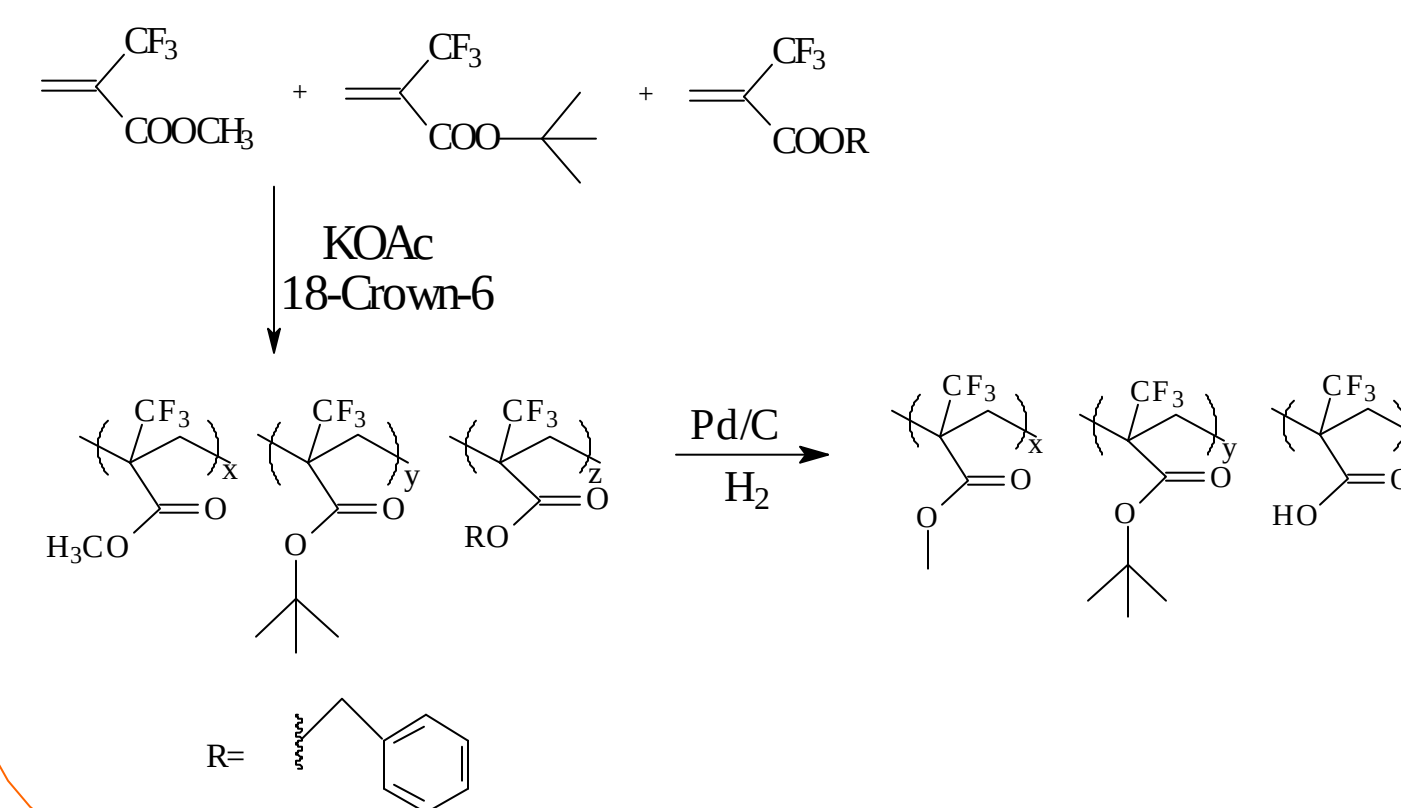
- *Synthesis Communications*, **1984**, 766-768
-Provides large quantities of highly pure acid

Protecting Group for Anionic Polymerization

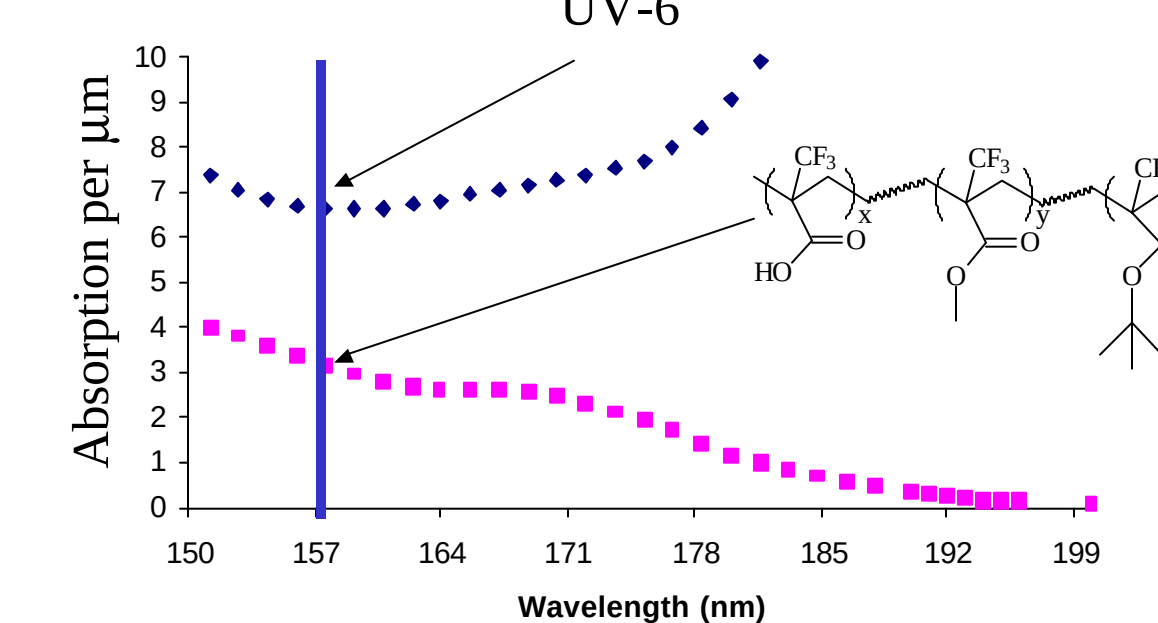


- *Journal of Fluorine Chemistry*, 39 (1988) 75-86
 - Can now prepare many primary and secondary alcohols
 - Benzyl ester can be hydrogenolyzed to produce acid

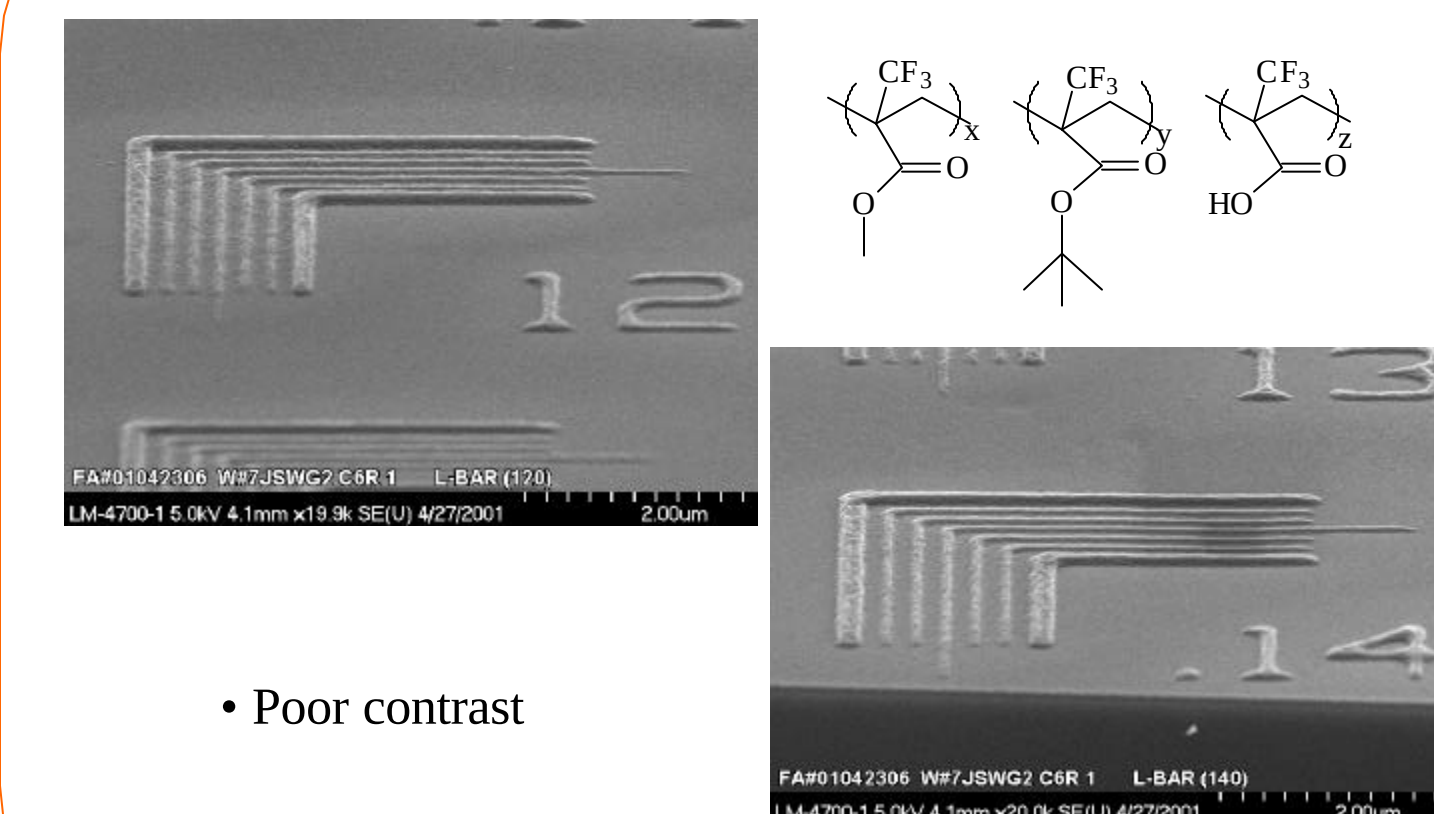
Anionic Polymerization/Deprotection



Absorbance Spectra

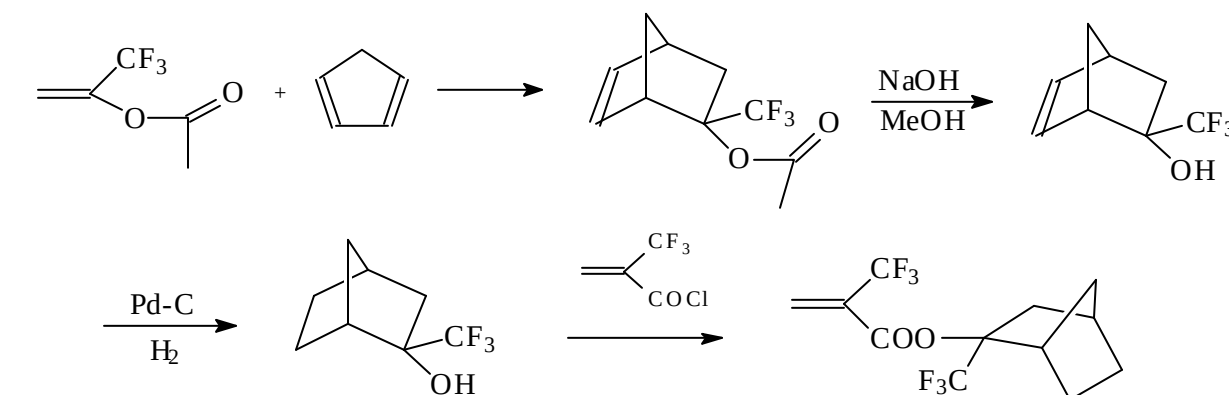


Preliminary 157 nm Imaging Studies

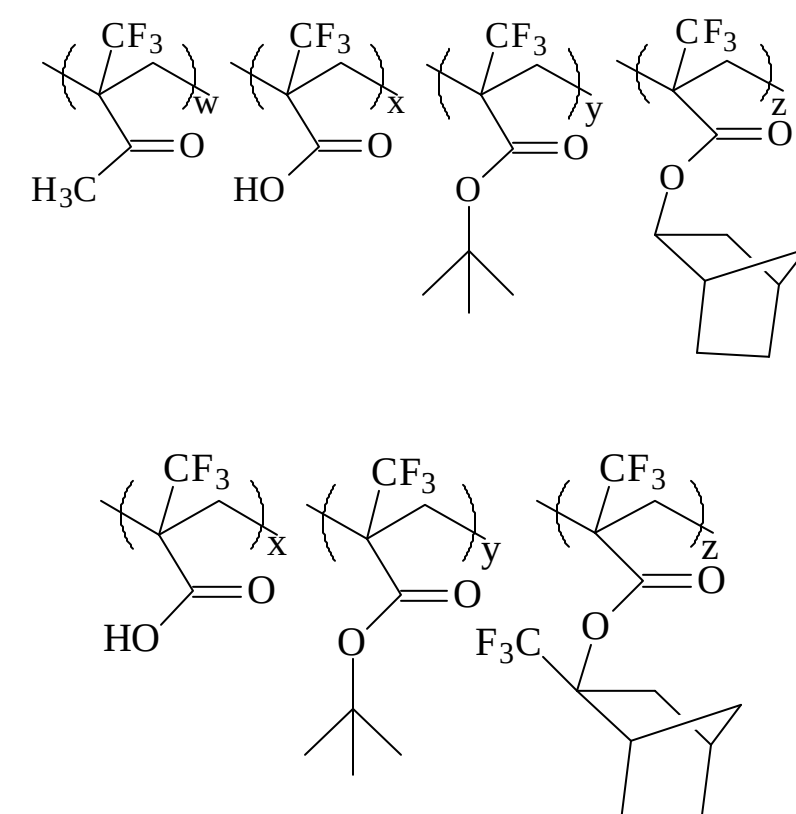


- Poor contrast

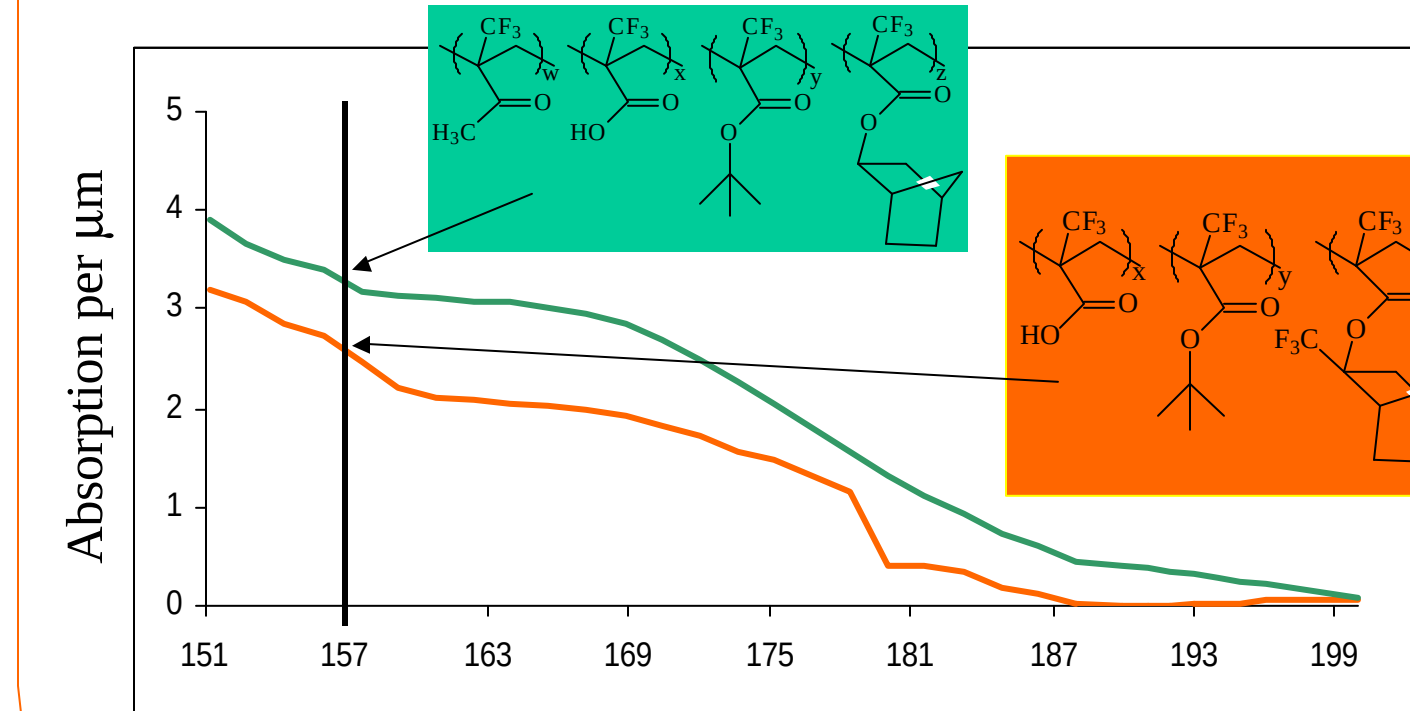
Etch Resistant Modules



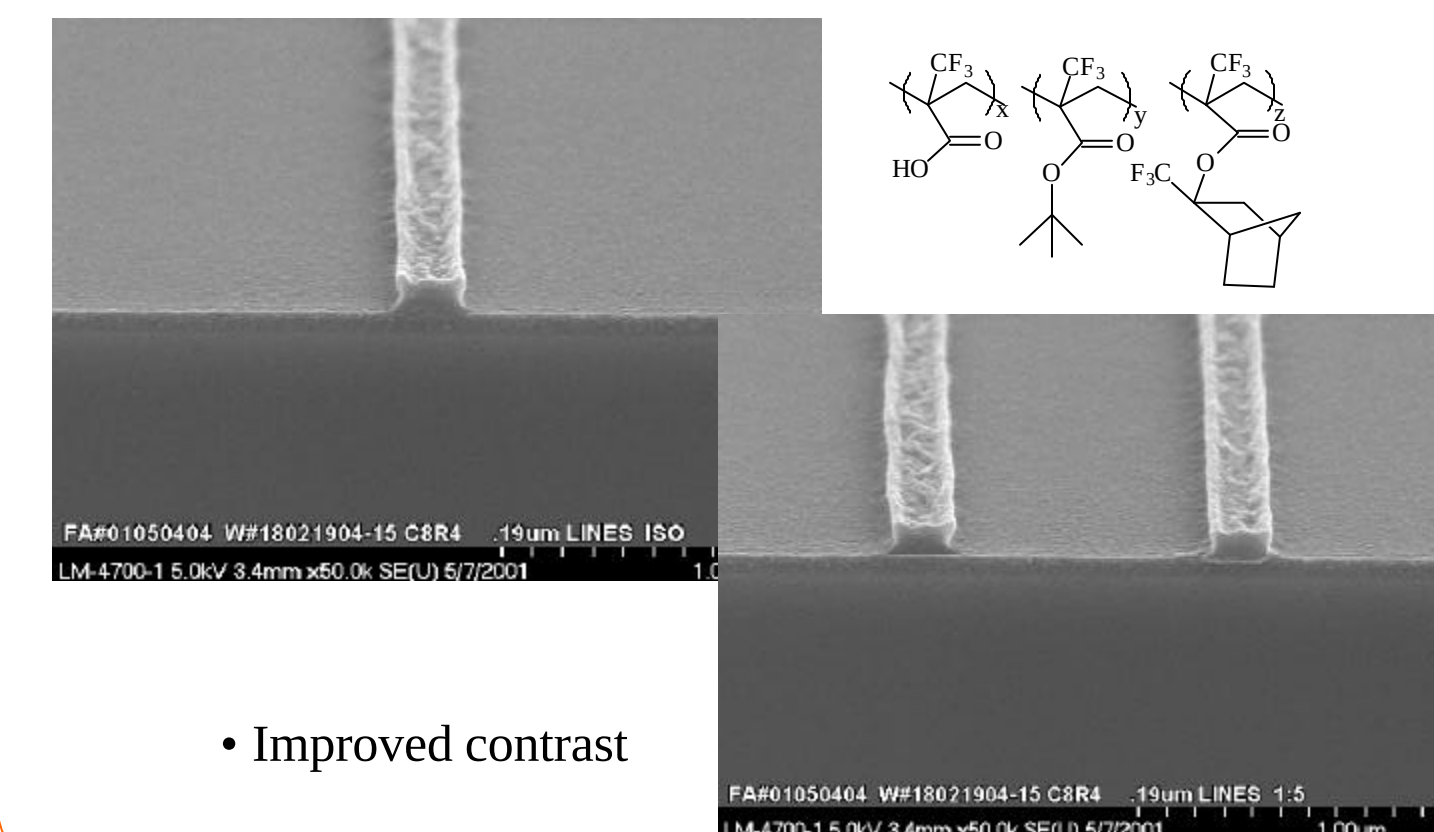
Acrylate Co-Polymers with Etch Resistance



VASE Spectroscopy



Preliminary 157 nm Imaging Studies



- Improved contrast

Conclusions

- Alkyl 2-(trifluoromethyl) acrylates offer improved transparency at 157 nm
- Various esters of these acrylates can be synthesized, providing the necessary functionality for resist design
- Preliminary studies of these co-polymers demonstrate successful positive-tone imaging at 157 nm exposure

Future Work

- Improve polymer transparency by incorporating fluorinated esters into the co-polymer
- Optimize dissolution contrast/properties
- Minimize swelling, residue
- Investigate impact of fluorinated norbornyl group on etch resistance

Acknowledgements

- Will Conley
- Daniel Miller
- Vicki Graffenberg
- Sematech

