



HIGHLY CONDUCTIVE POLYMERS

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Kevin P. Shambrook Ph.D.

707-529-4123

kevin.shambrook@gmail.com

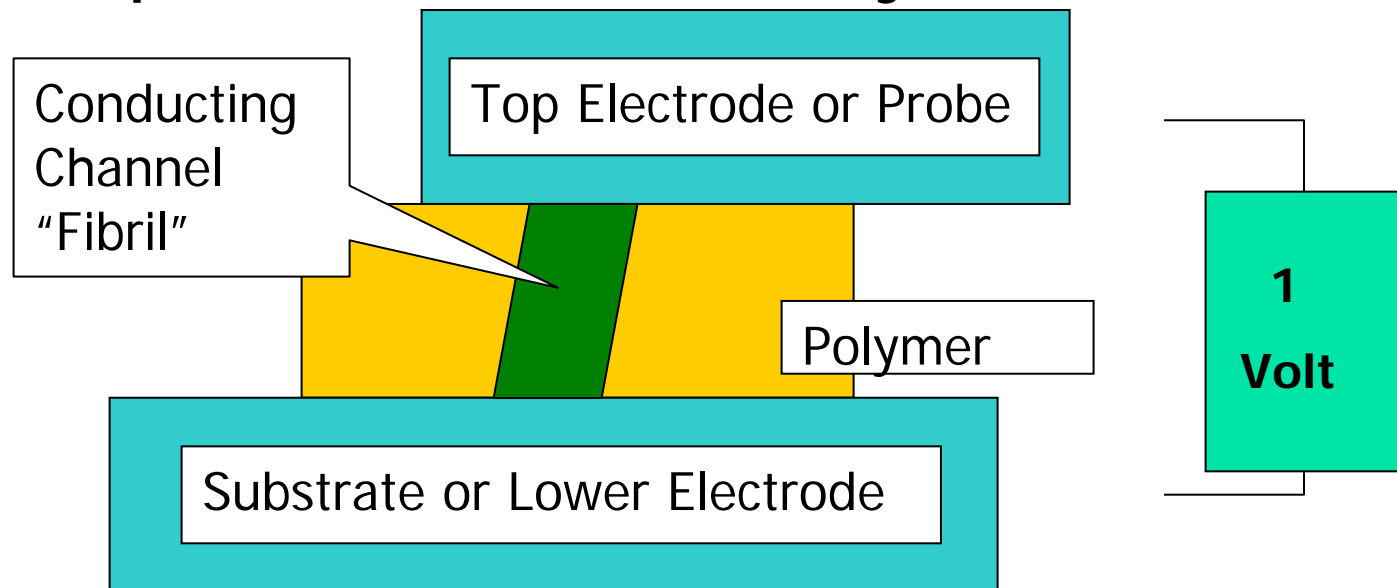


Outline

- HCP phenomenon
- Sample preparation
- Electrical measurements
 - Max. Current
 - Resistivity

The HCP Phenomenon

- Conduction is through the film
- Amorphous and Polar Polymer



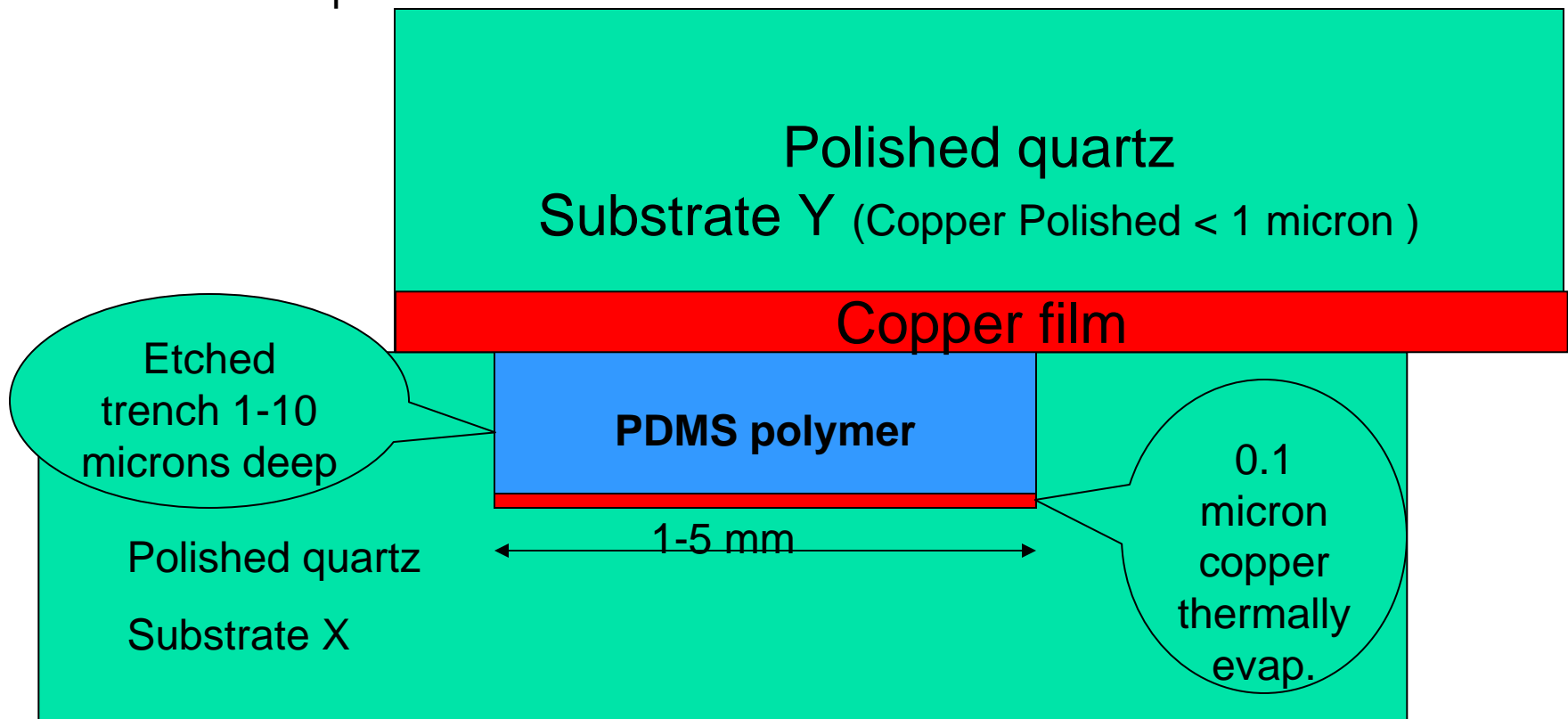


Sample preparation: Materials

- Poly(dimethyloxane) – PDMS
 - Does not need oxidation or any additional treatment
- Film Thickness
 - submicron to 10 microns
- Vary polymer viscosity
 - e.g. PDMS with different molecular weights
 - (250,000 – 2,500,000)

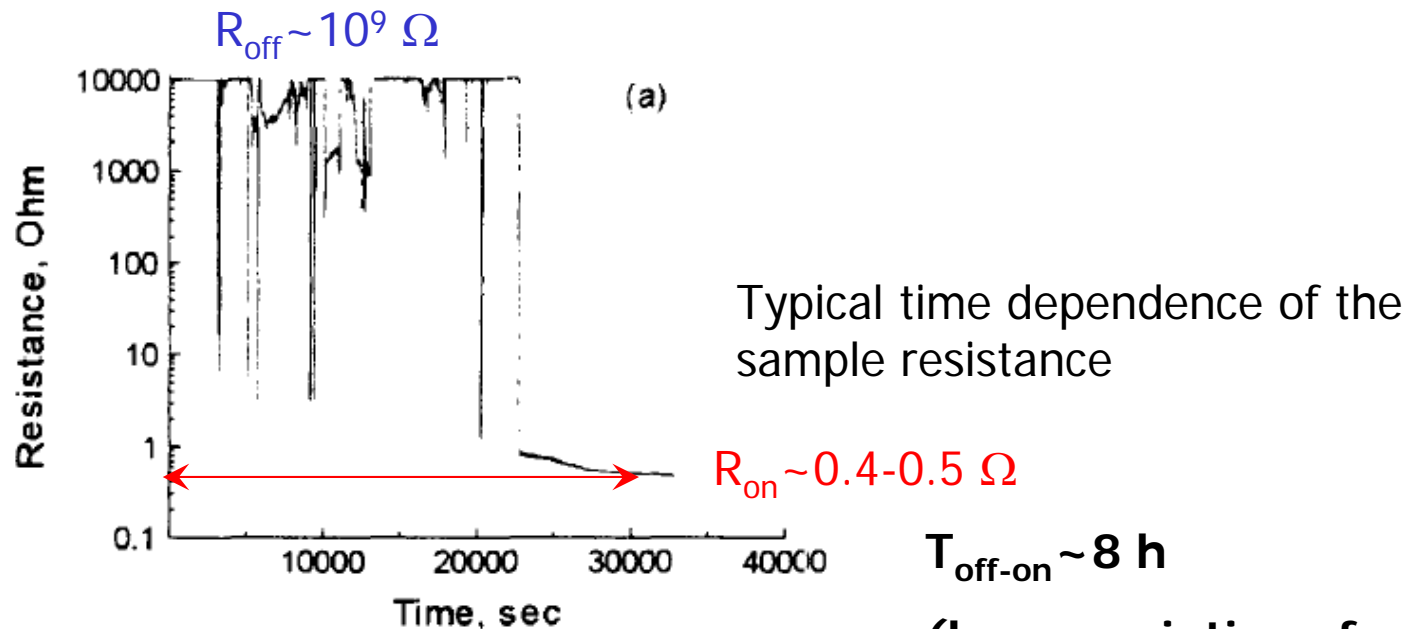
Sample Preparation: "Sandwich"

- Sample cross section 0.1 to 0.4 cm²



METHOD

- Apply polymer in groove between slides
- Apply 1 volt and monitor current



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(large variations for different samples)

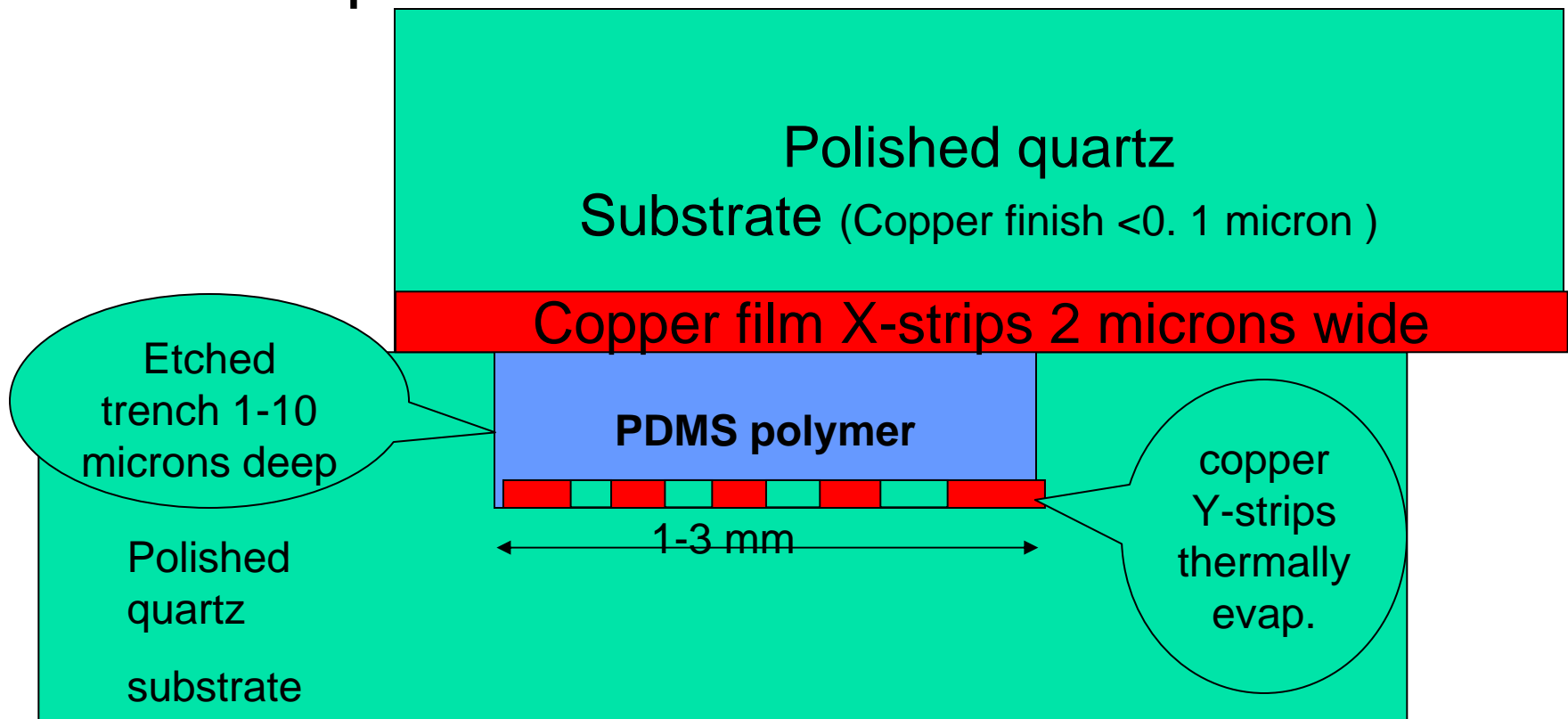


Goal and Objective

- Show unequivocally that conduction occurs in non-conjugated polymers
- Measure size of conducting regions
- Measure current density
- Estimate conductivity

"Sandwich" Crossbar

X-Y Strips fan out to connections





Measurements

- Current Concentration amp/sq.cm
- This can give an indirect estimate of a bound on conductivity
- Direct measure of resistance
 - Using Superconducting Electrodes
 - Using Current Persistence



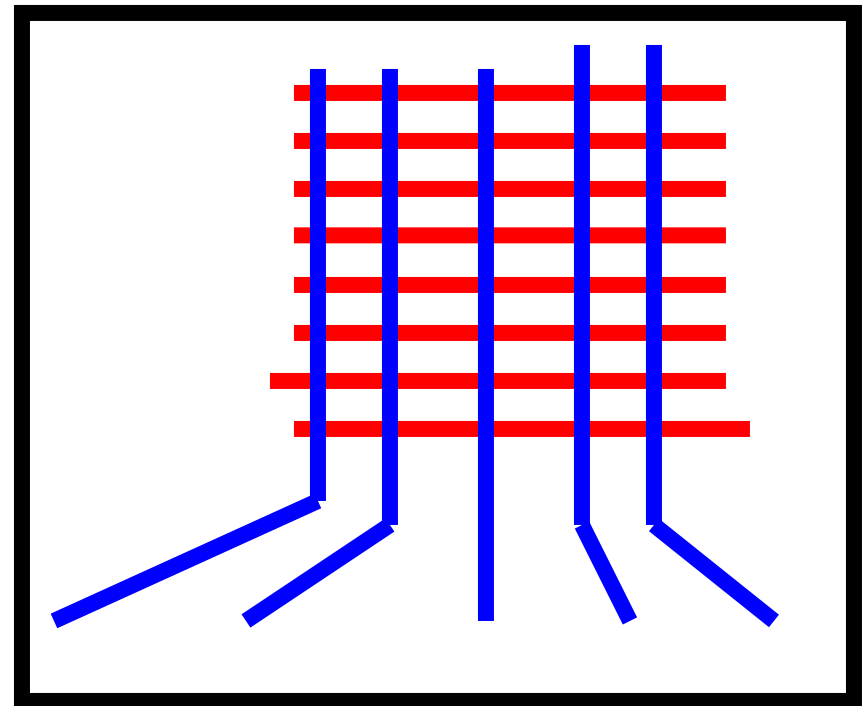
Current Concentration

- Conservative Measurement:
- Assume the whole area conducts
- Pulse up to 2000 amps/sq cm
- Use capacitor discharge
- Special needs: non-inductive resistor to measure current

Matrix Estimate of Conducting

Areas- Pulse current on only 1 X and 1 Y line

- Electrode Matrix X – Y
- Crossover area



Thermal Image of Area

Alternate to Matrix

- High current pulse will heat the conducting regions of the electrode
- This may be imaged with infra-red thermography



Resistance using Superconducting Electrodes

- The electrode material is Tin
- Cool down to about 2K
 - Tin superconducts at 3.8K
- Measure Resistance
- This eliminates the electrode resistance



Resistance using Persistent Current

- Join the tin electrodes to form a loop
- Cool to 2K
- Induce Current in the loop
- Measure the decay time
- This would give the best measure of resistance



Philosophy

- Keep it Simple
- Get definitive results
- Comments?