Measurements of Droplet Pinch-Off In Liquid Sodium

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Capillary Pinch-Off

- Application to fine-filament and inkjet production.
- Previously studied using strobe photography and high-speed video.
Problem With Optical Studies

- 1) The optical constraints of measuring nanometer-length scales
- 2) Geometry of pinch-off, which obscures the point of contact with the upper droplet.

Look! Obscured!!!
A New Way to Look at It!

• In a 2004 study from the University of California, Irvine, physicists J.C. Burton, J.E. Rutledge, and P. Taborek tested the minimum diameter of the pinch-off by running an electric current through a drop of liquid mercury.

By measuring the resistance across the droplet, they could find the minimum diameter $d$ using the expression for resistance of a cone:

$$d = \frac{2\rho_r \cot(\theta)}{\pi R}$$

The smallest neck diameter observed by Burton et al was about 2.7 nm.

But Why Sodium?

• 10X More Conductive than Mercury
  – 10X BETTER RESOLUTION
• Study Effect of Magnetic Fields
Experimental Design

• THE SODIUM BRIDGE
• THE VESSEL
• THE COPPER SHIELDING

- Reduces Electrical Noise
- Coaxial Ground
- Distributes Heat
- Containment/Structural Support
Running the Experiment

Gah! Problems!

• Sodium Melting?
• Sodium Purity
• Contact Wetting
• Sampling Rate
Data?

Voltage Traces During Trial Runs

Volts across 50 Ohm Resistor vs Time From Total Pinch-Off (sec) x 10^6
At Least It’s Not *Lohr*

*BAD STAR TREK PUN, © DON MARTIN*