Alkali-Free Glass as a High Energy Density Dielectric Material

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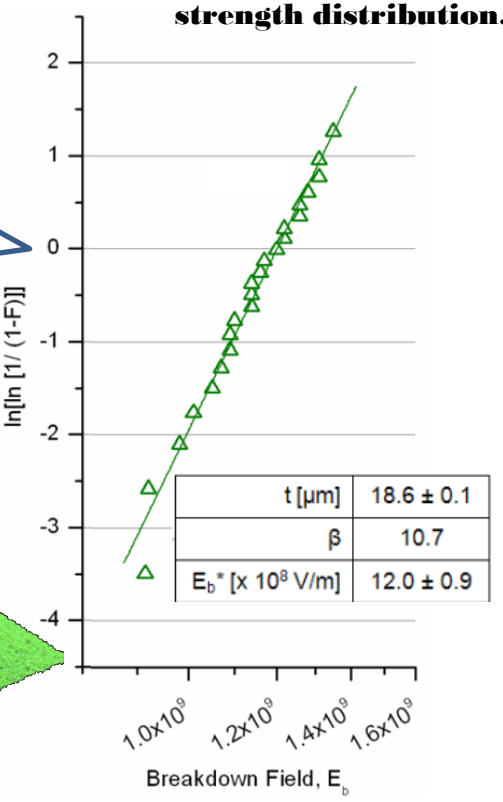
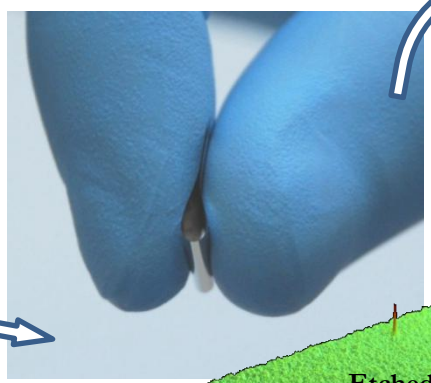
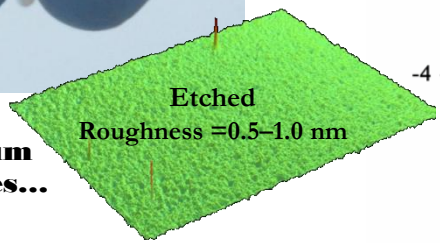
Next-generation electric vehicles, heart defibrillators, and weapons technology are driving a constant push for increased energy storage in capacitors—small devices that can provide quick bursts of electrical power. The amount of electrostatic energy that can be stored in a conventional capacitor dielectric material is limited by its permittivity and breakdown strength. We have found record-high breakdown strength in a bulk, alkali-free glass most commonly used in flat panel displays. The high breakdown strength and enhanced permittivity combine to yield remarkable energy density—as much as 3 times higher than today's most common material, polypropylene—indicating that glasses may represent a new frontier for energy storage.

...and test dielectric breakdown strength distribution.

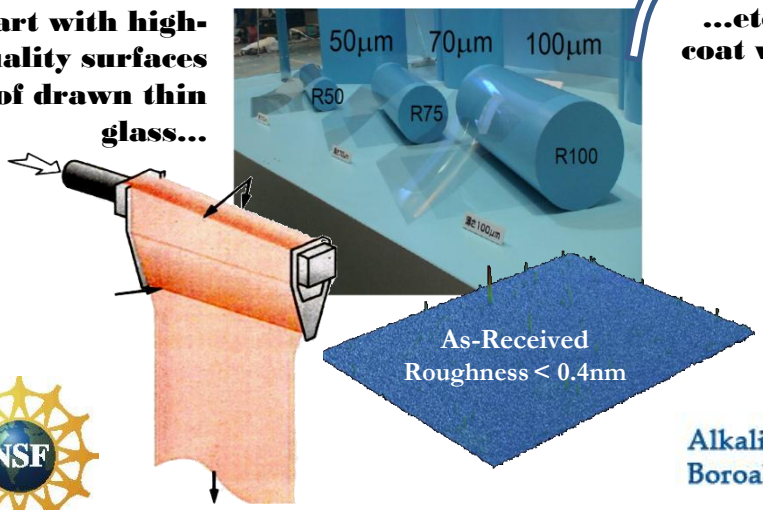




...etch to 10μm, coat with platinum electrodes...



Start with high-quality surfaces of drawn thin glass...



Dielectric material	Relative permittivity (25 °C, 1 MHz)	Breakdown strength (25 °C, DC) [MV/cm]	Energy density [J/cm^3]
Pyrex	4.8	4	3.4
Fused quartz	3.8	7	8.2
Alkali-Containing Boroaluminosilicate Glass	7.1 ± 0.4	4.2 ± 0.3	5.5 ± 0.8
Alkali-Free Barium Boroaluminosilicate Glass	6.0 ± 0.3	**12.0** ± 0.9	**38.5** ± 5.8