**Background & Introduction**

**Aerogels**
- Light-weight super-insulating material that in the native form is 99.88% air made by replacing the liquid material of a gel with air prepared with the sol-gel process. Aerogels have been extensively used in aerospace applications (e.g., insulation of Mars rover batteries) and are more recently investigated for green energy applications (e.g., home insulation) also. Aerogels can be synthesized from a variety of precursors, resulting in different types of physical and chemical properties [2,3,4].

Two types of aerogels were investigated in this study:

- **X-Silica Aerogel**
  - Cross-linked aerogels have added mechanical strength while preserving at least 50% of the original gel (normally 90%). Also, it is optically translucent.

- **Polyimide Aerogel**
  - Flexible and optically opaque.
  - Important for insulation of cryogenic tanks used for NASA applications, as depicted in the picture.

**Motivation**
The focus of this study was to prepare, synthesize, and characterize the film protective and antifouling coatings for two types of aerogel substrates. Our goal was to create a uniform and continuous thin film coating with 100% coverage of the surface underneath.

**Methods & Procedures**

**Choice of coatings**
- Dow Corning 3715 F5: This compound was chosen for this study and its properties were tested. It is a highly viscous solventless polymer made by mixing the base and curing agent in a ratio of 7:3 and allowing time for curing. Due to time limitations only one type of coating was tested. Both types of aerogels were tested and characterized.

**Characterization techniques**
- Mechanical agitation (testing bond strength) compression tests, surface coverage, and uniformity of coating tested by light microscopy. Contact Angle: to test surface properties. Coefficient of friction testing: to assess shear force and "slip & stick" properties.

**Variations in Experimentation**
1. **Drop cast**
   - 3715 onto aerogel and allowed it to spread and cure overnight.
2. **Method 1**
   - Drop 3715 on samples of polyimide before spinning at full speed (speeds: 4000, 5000, 6000, 6200, 7000, 8000 RPM)
3. **Method 2**
   - Dropped 3715 on samples of both types of aerogel while sample is spinning at full speed (speeds: 1000, 1000-8000 RPM)
4. **Outgassing**
   - Outgassed 3715 in oven until all bubbles were gone. Spincoated using new method at different RPMs (polyimide: 4000, 5000, 6000, 8000 RPM; silica: 4000, 5000, 8000 RPM).
5. **Mix Dow Corning 3715**
6. **Spincoated samples (made for us using previously published method)**
7. **Use light microscopy to image each sample at 5X.**
8. **Sonicate for 15 minutes in IPA.**
9. **Take contact angle measurements with ASTM V5000.**
10. **Complete friction tests with MRK-10 10N gauge with 200g steel plate.**

**Results**

**X-Silica Aerogel**

**Static Friction**
- Control vs. Drop-Cast
  - Static Friction: 0.39349 vs. 0.31998

**Kinetic Friction**
- Static Friction: 0.27863 vs. 0.30344

Ferrocyanide measurements for the control and drop-cast samples:
- a) Static Friction: very similar coefficients; can conclude that 3715 makes very little difference.
- b) Sonication/compression: 3715 adheres well to the surface.

**Polyimide Aerogel**

**Static Friction**
- Control vs. Drop-Cast
  - Static Friction: 0.56130 vs. 0.25128

**Kinetic Friction**
- Static Friction: 0.56130 vs. 0.25128

Ferrocyanide measurements for the control and drop-cast samples:
- a) Static Friction: very similar coefficients despite variables.
- b) Sonication/compression: 3715 rubbed off easily like powder or paint.

**Conclusion & Summary**

- Friction: drastically different coefficients can conclude that 3715 lowers the coefficient of friction.
- Sonication/compression: 3715 adheres very similar static and kinetic friction coefficients.

**Contact Angle**

**X-Silica Aerogel**

**Static Friction**
- Control vs. Drop-Cast
  - Static Friction: 0.39349 vs. 0.31998

**Kinetic Friction**
- Static Friction: 0.27863 vs. 0.30344

**Polyimide Aerogel**

**Static Friction**
- Control vs. Drop-Cast
  - Static Friction: 0.56130 vs. 0.25128

**Kinetic Friction**
- Static Friction: 0.56130 vs. 0.25128

Ferrocyanide measurements for the control and drop-cast samples:
- a) Microscope: little difference between all variations.
- b) Friction: very similar static and kinetic friction coefficients despite variables.

**Future Works**

- Improve the surface coverage by rendering the surfaces more hydrophilic, prior to coating of substrate.
- Characterizing the spin conditions as a function of film thickness.
- Finding a computer software to calculate the percent coverage of each of the samples.
- Experimenting with different ratios of 3715 (base: curing agent) to decrease viscosity.
- Test the coatings under cryogenic temperatures to see how the 3715 affects the insulation of aerogels.

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