Adhesion and Detachment
Mechanisms of Polymer Surfaces

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Big Picture

- This project primarily focuses on adhesion and separation of polymers

Patterns associated with these processes.

- There is a broad range of applications from this research.
Processes

Preparation of polymer thin films → Measure surface and interfacial energy

Conclusion (relate the experiment results to theory) → Measure the adhesion and the friction of polymer films
Spin Coating

- Solution
- Substrate
- Vacuum Chuck
- Motor
Surface and interfacial energy

- Set up used for contact angle measurements and radius spread.
- Drop is recorded using a digital camera.
- With contact angle, we can calculate the surface energy of the polymer.
- We can also plot the data to get graphs which can help us see the growth rate of the radius and the decrease rate of the contact angle.
High surface energy vs. low surface energy

Block polymer with low surface energy

Block polymer with high surface energy

Water

100°

45°

07-06-07 16:39:14

07-10-07 14:16:03
Surface Force Apparatus (SFA)

- Approximately 3.5”x5”x4”.
- Price of box itself is $200,000.
- Designed by Dr. Jacob Israelachvili.
- Measure the thickness, adhesion and friction forces, contact distance, and pull off velocity of polymer films.
- We can also relate this information with surface and interfacial energy.
Fringes of Equal Chromatic Order (FECO)

Multiple Beam Interferometry in the Surface Forces Apparatus

M. Heuberger et al., Langmuir, July 9, 1997
Our Results: Symmetric Case

- S-T instabilities

Diagram showing the approach and separation phases with various labels and measurements.
Growth of the contact region

\[ r = \frac{(r_i + r_0)}{2} \propto t^n, \]

where \( n = 0.2-0.3 \)

\[ D = C_1 e^{-t/\tau_1} + C_2 e^{-t/\tau_2} + C_3 \]

where \( C1, C2, C3 \) are constants, and \( \tau_1 << \tau_2 \)
Our research is mostly fundamental which practices theoretical methods.
Adhesion and detachment mechanisms can contribute to many fields.
Make better adhesive polymers.
Propose better theories for detachment mechanisms.
Have a better understanding of adhesion mechanisms and theories.
Thin film, related to cell-cell coalescence (potential application).
What did I learn in this research?

- Surface energy.
- Adhesion of polymers, thin films
- Liquid-liquid coalescence.
- Effects of viscosity on adhesion and detachment.
- Finger instabilities with adhesive contacts of materials from liquid-like to solid-like.
- Contact angle measurements and its relation to surface energy.
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