

Adhesion and Detachment Mechanisms of Polymer Surfaces

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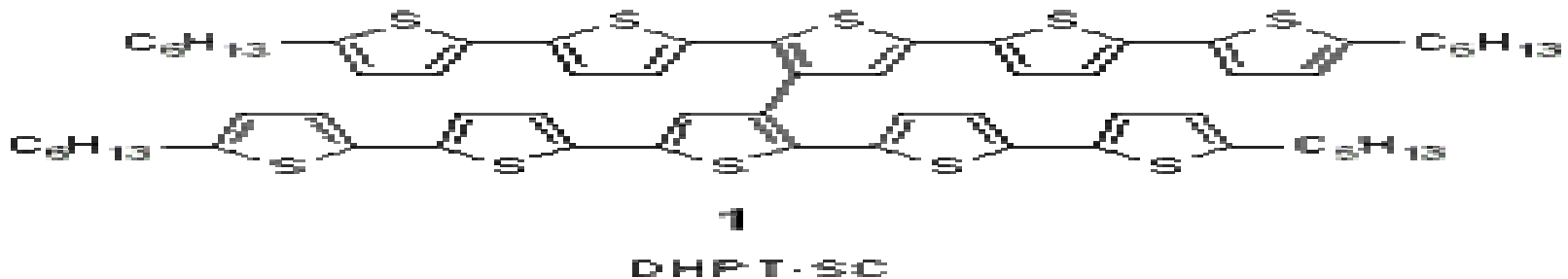
Dr. Jacob Israelachvili

NSF, DOE, NASA

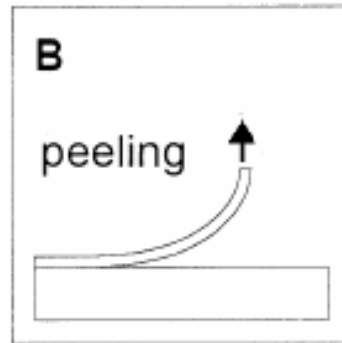
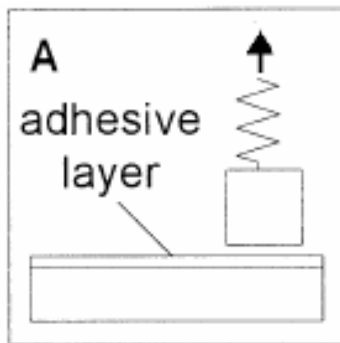


Big Picture

- 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

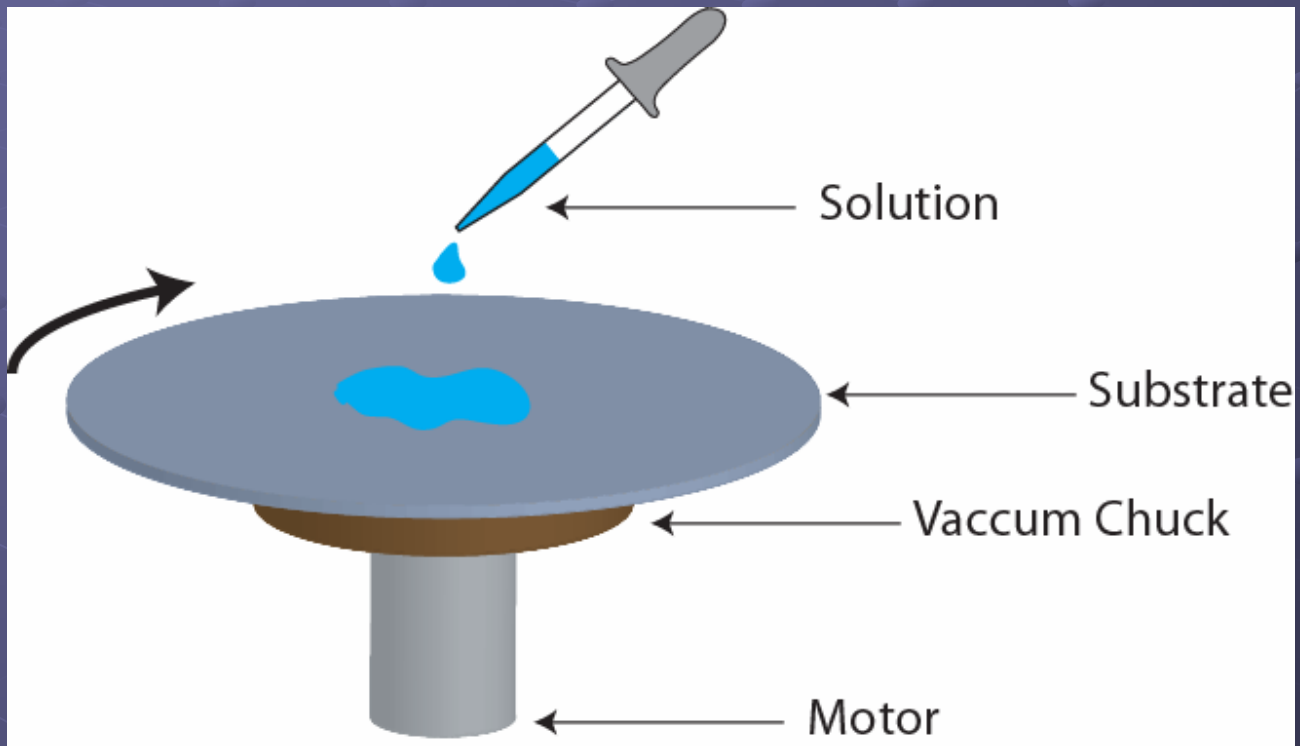


Conclusion
(relate the experiment results
to theory)



Measure the adhesion and the
friction of polymer films

Spin Coating

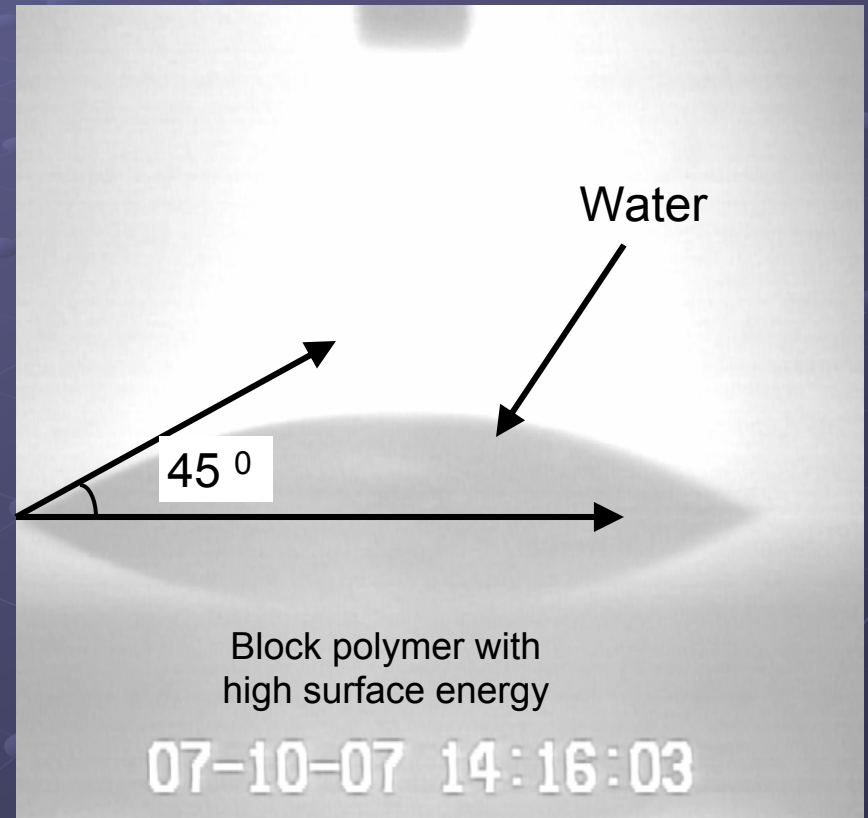
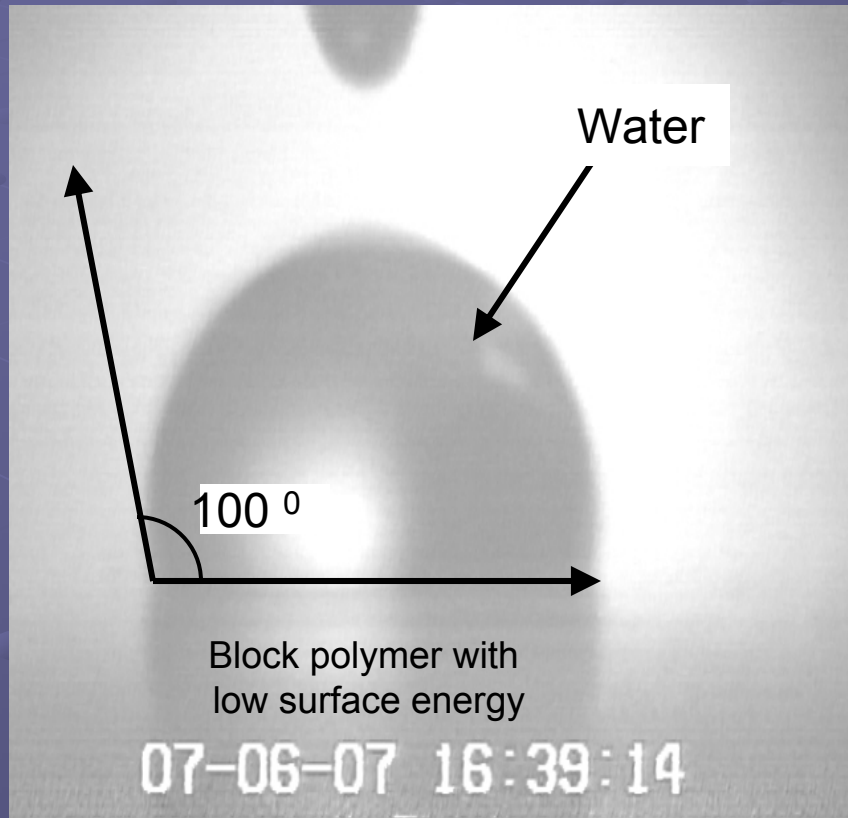


Surface and interfacial energy

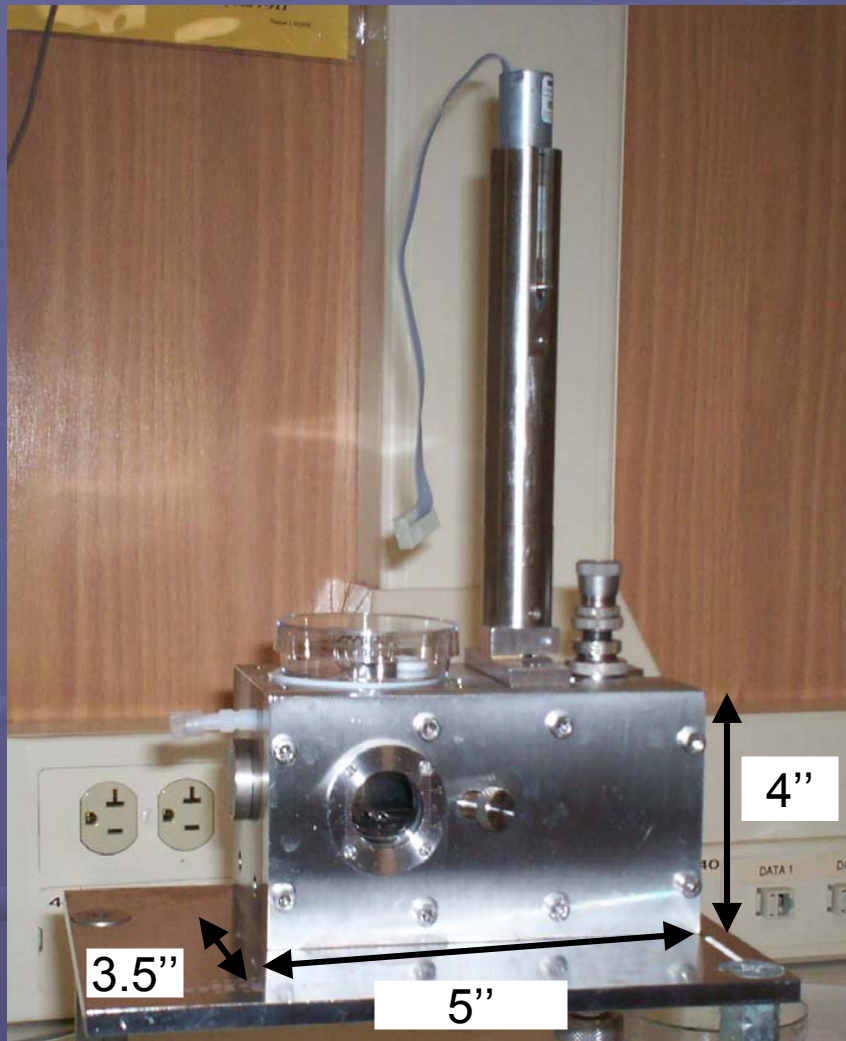


- Set up used for contact angle measurements and radius spread.
- Drop is recorded using a digital camera.
- With contact angle, we can calculate the surface energy of the polymer.
- We can also plot the data to get graphs which can help us see the growth rate of the radius and the decrease rate of the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

High surface energy vs. low surface energy



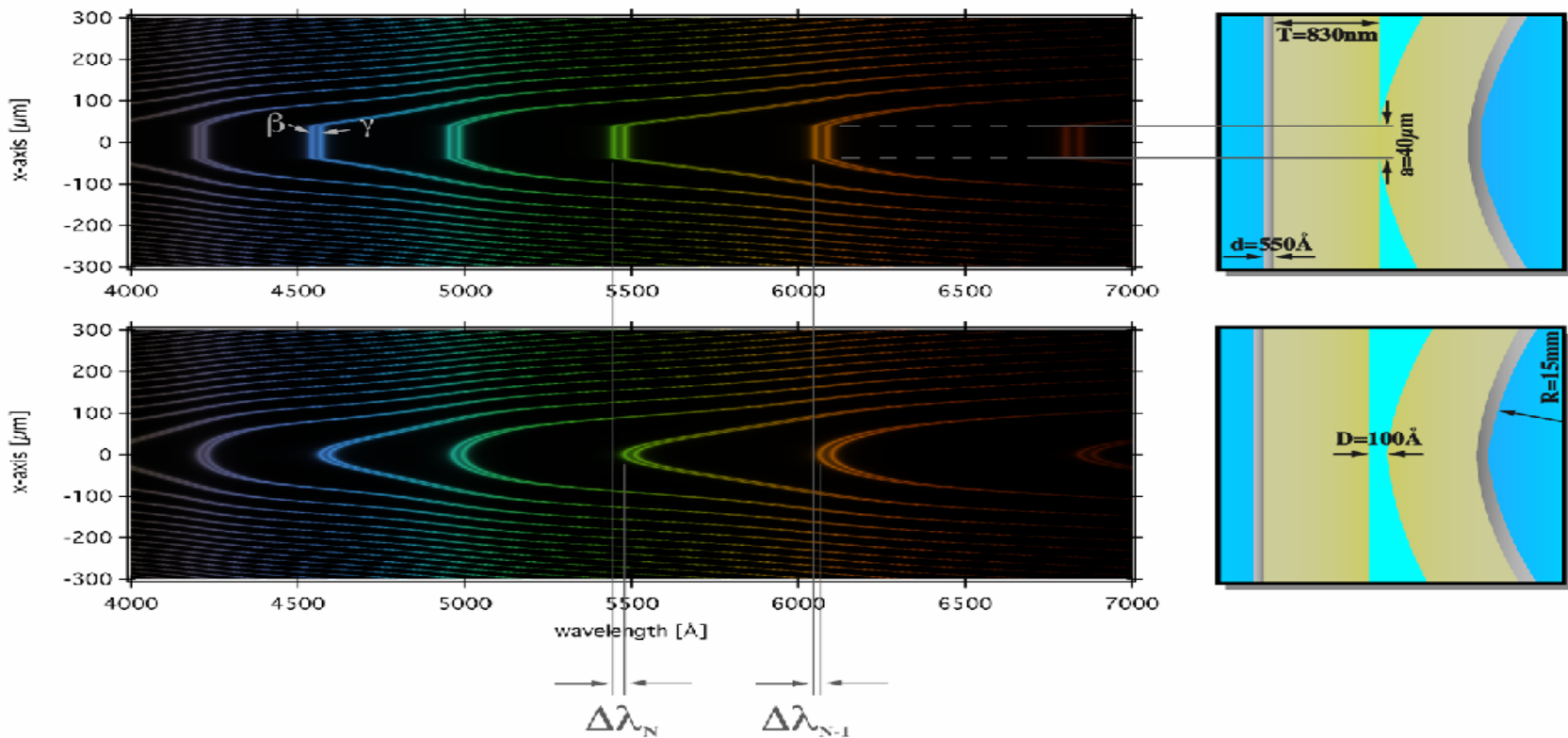
Surface Force Apparatus (SFA)



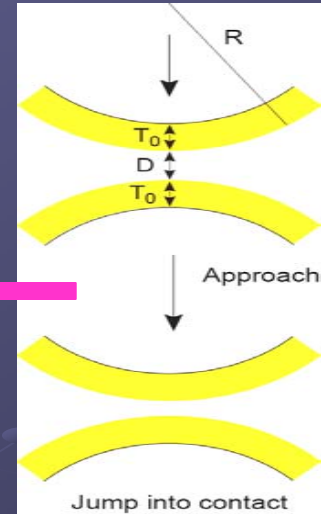
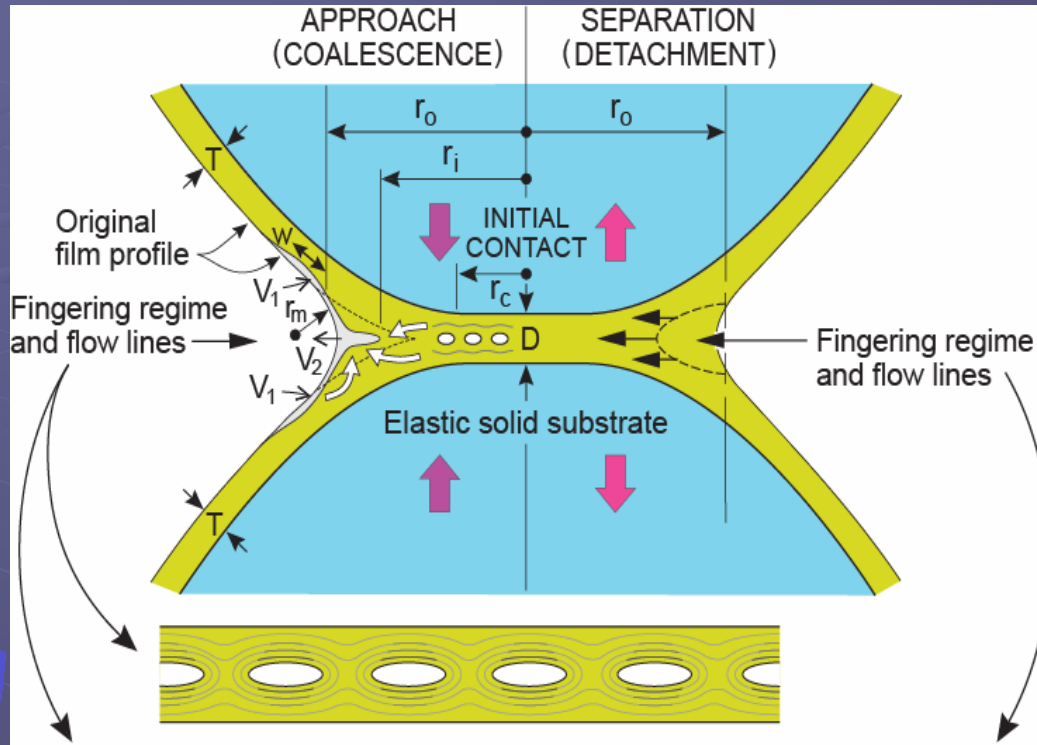
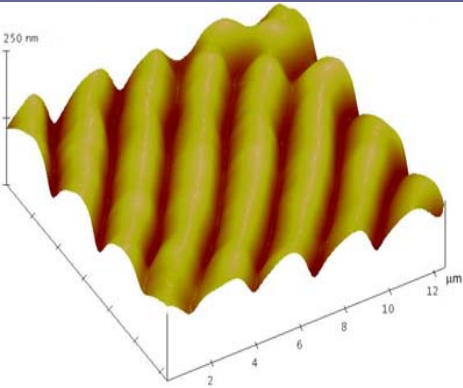
- Approximately 3.5"x5"x4".
- Price of box itself is \$200,000.
- Designed by Dr. Jacob Israelachvili.
- Measure the thickness, adhesion and friction forces, contact distance, and pull off velocity of polymer films.
- We can also relate this information with surface and interfacial energy.

Fringes of Equal Chromatic Order (FECO)

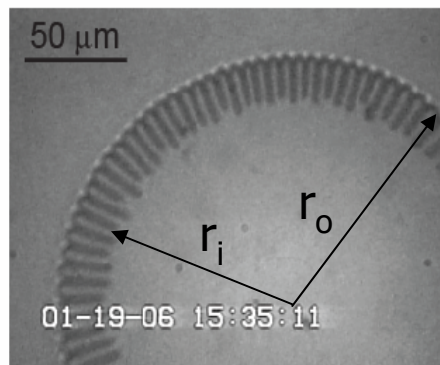
Multiple Beam Interferometry in the Surface Forces Apparatus



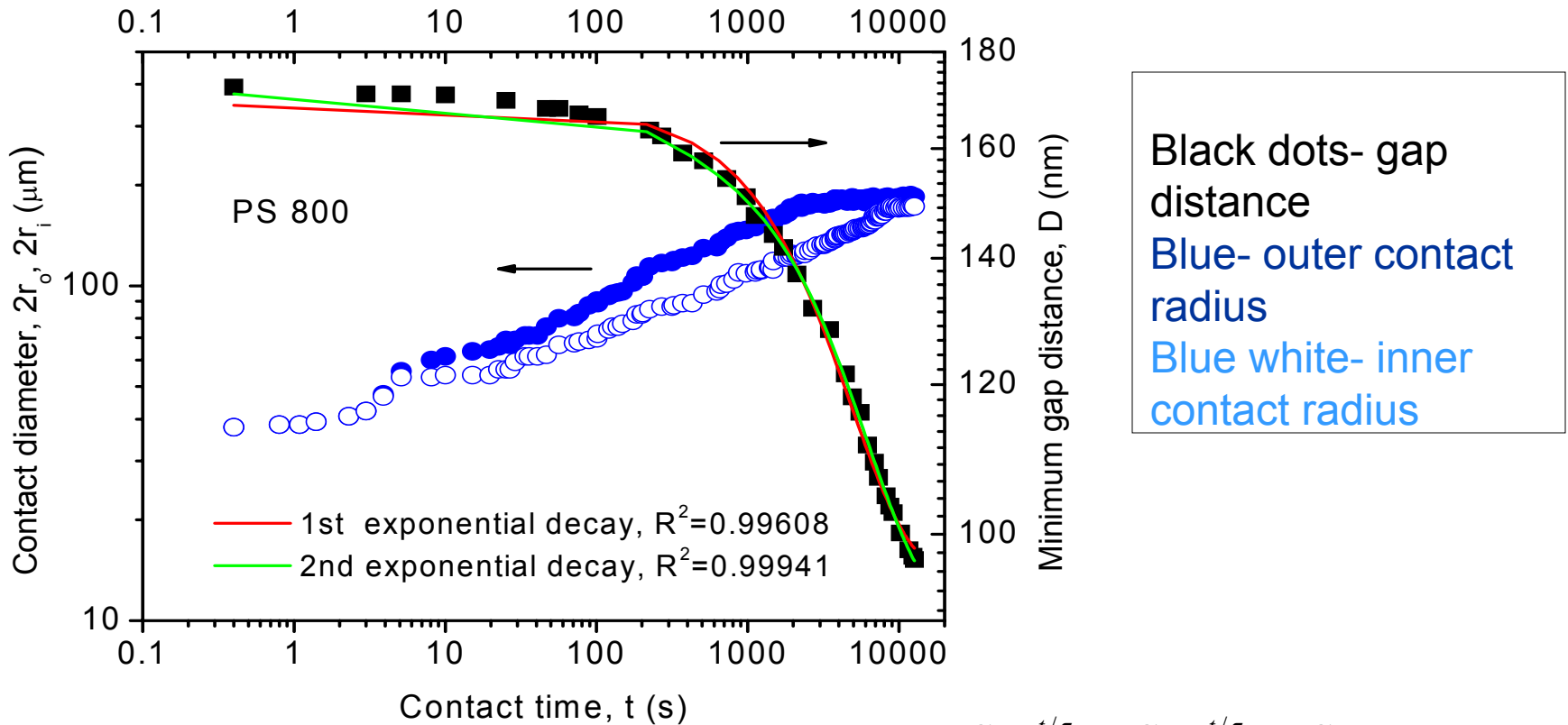
Our Results: Symmetric Case



S-T instabilities



Growth of the contact region



$$r = (r_i + r_o) / 2 \propto t^n,$$

where $n = 0.2-0.3$

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

where C_1, C_2, C_3 are constants,
 and $\tau_1 \ll \tau_2$

Future Plans

- 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.

Acknowledgements

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Interfacial Laboratory

CNSI

INSET