Lecture-31-40 Spontaneous instability & Dewelting of Thin Polymer Film

31.1. What is the role of surface tension in dewetting of an ultra thin film?

Ans: Surface tension has a unique role in terms of stability and dewetting of ultra thin polymer films. Initially, in an intact film surface tension opposes the growth of the thermal fluctuation spectrum at the film surface, which tend to grow due to attractive inter surface van der Waals forces. However, once a hole ruptures, then surface tension reverses its role, as it favors hole growth.

31.2. Is it possible to have a situation where the surface fluctuations on the film surface might be absent?

Ans: The surface fluctuations are due to the kinetic energy of the molecules, which have expression kT, where k is Boltzman Constant and T is absolute temperature. Thus the fluctuations will be absent only at absolute zero. Under experimental conditions, as the films are heated beyond the glass transition temperature, the fluctuations will always be present.

31.3. Why does rim form around a growing hole in dewetting?

Ans: The Rims appear around a growing hole in the dewetting of a thin polymer film due to mismatch between the rates at which the polymer gets dislodged from the substrate and gets redistributed to other intact parts of the film, which is slower. The rims thus appear as a signature of localized accumulation.

31.4. What are the difference between dewetting of a purely viscous and a visco –elastic polymer thin film?

Ans: In dewetting of a purely viscous polymer thin film, the rims are symmetric and have a circular cross section. Also the rims appear right after the formation of the holes. In contrast, in dewetting of a visco elastic thin film, the holes initially form without any rim. Subsequently, when the rims appear, they have highly asymmetric shape. Also, the hole growth may be hindered beyond a critical diameter in the latter case.

31.5. What is the fundamental difference between thermal dewetting and Solvent vapor induced dewetting?

Ans: In thermal dewetting, the polymer is heated beyond the glass transition temperature. In contrast, exposure to solvent vapor leads to swelling of the polymer and therefore the glass transition temperature drops below room temperature. However, the main difference between thermal and solutal dewettings is that the cause of instability is the longrange force of van der Waals interactions in the thermal dewetting whereas it is the short-range force of polar interactions in the solutal dewetting.

31.6. What is a metastable film?

Ans: A film is metastable if it is unstable below a critical film thickness and becomes table above that critical thickness. Majority of polymer thin films on non wettable surface are metastable as they tend to become stable with increase in film thickness.

31.7. How can a thermodynamically stable film exhibit dewetting?

Ans: A thermodynamically stable film may dewet on a high energy surface due to nucleation of holes around heterogeneities.

31.8. **What is long wave instability?**

Ans: It implies that the periodicity of instability is much higher than the amplitude of the surface undulations. .

31.9. **Can dewetting be suppressed in any way? How?**

Ans: Dewetting can be suppressed by adding nanoparticles to the polymer film. The particles preferentially settle on the substrate and alter its properties, thus altering the Hamakar constant, suppressing dewetting.

31.10. **In contrast to dewetting of an ultra thin polymer film, one is observing the dewetting of a water film of similar thickness. What are the likely differences in the two systems?**

Ans: The holes in a water film may not have rims. Also the dynamics would be much faster given the difference in molecular weights. The entanglement effect seen in polymer films also contributes to slower dynamics.

31.11. **Q: what is the importance of template-guided dewetting?**

Ans: By template-guided dewetting, it can be shown that dewetting can be controlled and ordered. An ordered array becomes a new template for further processes eg, electronic wafers.