Cracking of latex films during drying

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When latex films are cast on a substrate they crack if the temperature is below some critical value called the crack point. This temperature is related to the glass transition temperature of the constituent polymer. At temperatures below the crack point, where the film fails, the spacing between cracks decreases with decreasing temperature eventually asymptoting to a constant value. This is very elegantly shown with an MFT bar experiment.

Cracking in films is determined by the stresses pulling the material apart. These stresses are dependent on the mechanism of particle deformation in the film. Previous work has shown how temperature is the crucial parameter in determining the deformation mechanism and consequently the transverse stress [1,2]

Intuition implies that a capillary deformation mechanism imparts a compressive transverse stress and therefore eliminates any possibility of cracking. However defects can propagate under high capillary stresses if the film is above a critical film thickness. For lower thickness, van der Waals attraction between neighbouring particles, leads to a macroscopic bulk tension and the possibility of failure.

This talk will discuss the different mechanisms of failure and which will lead to the observed temperature dependence on the crack spacing. Experimentally the presence or lack of water is crucial. Preliminary experiments will be highlighted which seem to indicate the presence of a critical film thickness for cracking under a capillary deformation mechanism.

References

[1] A. F. Routh and W. B. Russel, *A process model for latex film formation: Limiting regimes for individual driving forces*, Langmuir 15 (22) 7762 1999.

[2] A. F. Routh and W. B. Russel *Deformation mechanisms during latex film formation: Experimental evidence*, Industrial & Engineering Chemistry Research 40 (20) 4302-4308 2001.