Cracking During Drying of Latex Films

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Drying latex above its glass transition temperature, T_g results in a transparent, homogeneous film. Below the glass transition temperature, the particles are too rigid to be deformed by the stress developed in the film during drying. The stress will pull the film apart at places where defects are present. Previous studies on film cracking have made the assumption that the film is a continuum medium. Cracking was modelled as a balance of energy in creating a new surface to the elastic energy released. The result is a scaling of the crack spacing to the thickness of the film. This scaling only partially collapses the data, suggesting other mechanism present. In this talk, we introduce a new scaling to collapse the data for crack formation in latex films based on the capillary pressure. When the film fails, reduction in volume due to crack formation sends a flow of water to the surrounding area, relieving the capillary stress. We propose that the distance of flow governs the crack spacing. A capillary length scale, which is the distance where capillary stress relaxes, is modelled to collapse crack spacing data. At elevated temperature, particle deformation takes place, increasing the volume fraction of particles and the magnitude of capillary stress in the film. By calculating the change of particle volume fraction and capillary stress with temperature, we are able to collapse the data using the same scaling. Dufresne et at (2004) observed that cracks propagates in a step wise manner. A flow of water released when the film cracks temporarily relieves the pressure around the crack. As evaporation of water continues, the pressure increases again until the yield strength of the material is reached, and the crack propagates. Using a high speed camera, we are able to obtain the 'jumping' frequency and the jump length, which is the distance the crack moves with each jump. We are developing a model to collapse the data.