Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Evaporation-driven Fracture of Colloidal Drops Undergoing a Sol-gel Transition[1] ARANDEEP UPPAL, Imperial College London, MATTHEW HENNESSY, University of Oxford, RICHARD CRASTER, OMAR MATAR, Imperial College London — Evaporation of liquid from a colloidal suspension can lead to a sol-gel transition whereby the mixture is transformed into a soft, gel-like material consisting of closely-packed particles with liquid-filled voids. If a drop of colloidal fluid is placed on a solid substrate, then non-uniformities in the evaporation rate lead to a gelation front that propagates from the contact line towards the center of the drop. Afterwards, uniformly spaced, radially aligned cracks begin to form near the contact line which themselves propagate into the bulk. By varying the composition of the drop, a myriad of striking fracture patterns can be observed. To describe this evaporation-driven fracture process, we have developed a fully-coupled poroelastic-damage model. The model is systematically reduced by exploiting the small contact angle of the drop and the resulting equations are solved using the finite element method. The model confirms that fracture is driven by the generation of tensile stresses at the contact line caused by the adhesion of the solid matrix to the substrate and volumetric contraction due to fluid loss. Our simulations are able reproduce the experimentally observed fracture patterns and reveal that slip plays a key role in selecting the resulting morphology.

[1]Engineering and Physical Sciences Research Council, UK, Centre for Doctoral Training in Fluid Dynamics across Scales (EP/L016230/1)

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Date submitted: 29 Jul 2019

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