Dynamics of Surfactant-laden Liquids Spreading on Gel Substrates

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ABSTRACT

This work involves an experimental investigation of the spreading of liquids on gel layers in the presence of surfactants. Of primary interest is the instability that accompanies the cracking of agar gels through the deposition and subsequent spreading of a drop of surfactant solution on their surface. This instability, which has been reported recently in the literature[1], manifests itself via the shaping of crack-like spreading "arms", in formations that resemble "starbursts". A detailed study of the spreading of different surfactants on various gels aims to investigate the ways that system parameters such as the surfactant chemistry and concentration and the gel type and strength can affect the morphology and dynamics of the cracking patterns. The surfactants used in this work include SDS (Sodium Dodecyl Sulphate) and the "super-spreader" Silwet L-77 (a Trisiloxane ethoxylate); the different gel substrates are made of agar (a polysaccharide-based gel) and gelatin (a protein-based gel).

The instability is characterised in terms of the number of arms that forms, and their length as a function of time. It is observed that the presence of Silwet L-77 leads to the formation of cracking patterns over wider ranges of gel and surfactant concentrations, and promotes faster evolution of the "arms" than SDS. Qualitative and quantitative information on the surfactant distribution is also obtained, together with rheological characterisation of the gel layers.

In the majority of the cases investigated, the length of the "arms" is found to grow as $t^{2/3}$. Marangoni stresses generated by surface tension gradients between the surfactant droplet and the uncontaminated gel layer are identified to be the main driving force behind the observed phenomena.

REFERENCES

[1] K.E. Daniels, S. Mukhopadhyay, P. J. Houseworth and R. P. Behringer, "Instabilities in droplets spreading on gels," Phys. Rev. Lett. **99,** 124501 (2007).