DROPLET EVAPORATION: MATHEMATICAL MODELLING AND EXPERIMENT

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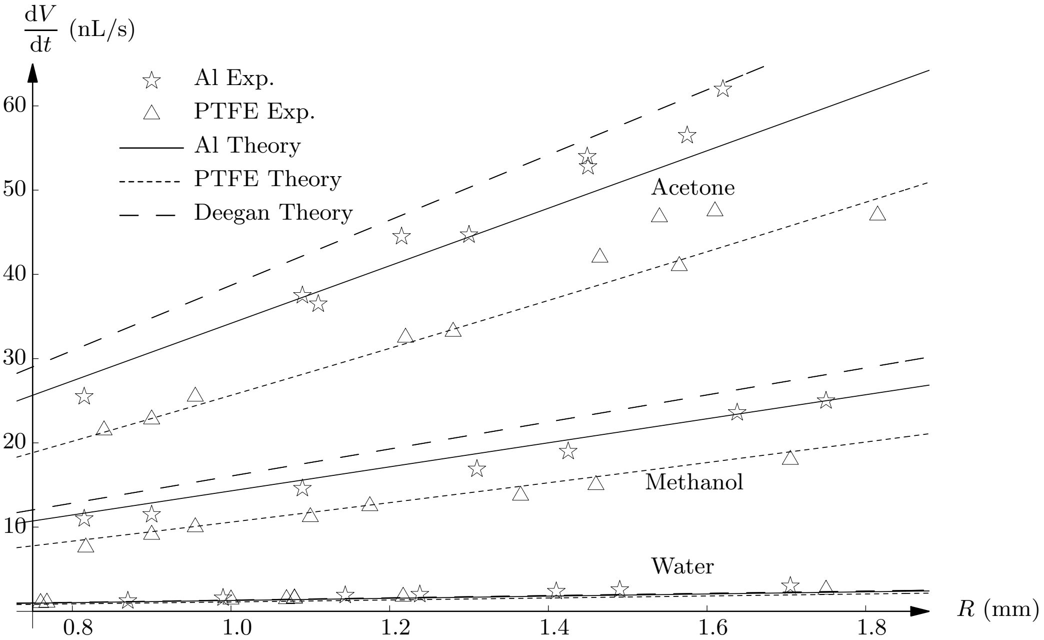
A mathematical model for the evaporation of an axisymmetric sessile droplet of liquid whose contact line is pinned by surface roughness (or other) effects is developed and analysed. We compare the predictions of our mathematical model with recently obtained experimental results.

The droplet rests on a substrate and evaporates under controlled conditions. In particular, the droplet is neither heated nor cooled externally, and the atmosphere surrounding the droplet is at room temperature, so that evaporation is limited by the diffusion of the vapour away from the droplet surface. In the experiments each droplet is much smaller than the capillary length, and so we assume that its free-surface profile has the shape of a spherical cap.



Current models capture many of the key physical processes but do not include all the physical effects that are often significant in practice. For instance, previous work neglects the thermal conductivity of the substrate, but experiments reveal that this can play an important role in the evaporative process. For example, for a droplet of acetone on a poorly conducting substrate, such as PTFE, the temperature on the droplet surface is approximately 8 K less than the temperature of the surrounding atmosphere; this considerably reduces the concentration of water vapour at the surface of the droplet and so the evaporative mass flux is significantly reduced compared to that on a better conductor. Other physical effects that have been investigated experimentally include reducing the pressure in the surrounding atmosphere and replacing the surrounding air with various other gases. In this talk we report on extending the existing mathematical models to include all of these physical effects.

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