Kinetics of evaporation of liquid droplets [Abstract]

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Citation: SEMENOV, S. ...et al., 2011. Kinetics of evaporation of liquid droplets. Presented at the 25th European Colloid and Interface Society (ECIS), Berlin, Sept. 4-9th.

Additional Information:

- This is an abstract of a conference paper.

Metadata Record: https://dspace.lboro.ac.uk/2134/25824

Version: Published

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Kinetics of evaporation of liquid droplets

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The total flux of evaporation from the sessile droplet is proportional not to the total liquid-vapour interface but to the perimeter of the droplet. It is usually assumed that the latter is caused by a substantial increase of the local evaporation flux in a vicinity of the three phase contact line. We showed that the proportionality of the total evaporation flux to the perimeter of the sessile droplet has nothing to do with the local flux increase in a vicinity of the three phase contact line but is a consequence of governing equation and remain valid even in the case when the local evaporation flux is constant over the whole surface. Computer simulations of the instantaneous flux at evaporation of sessile droplets are carried out in a self consistent way by considering an interconnected problem of vapour transfer, heat transfer in vapour, liquid and solid substrate, and Marangoni convection inside the liquid droplet [1]. The influence of thermal conductivity of the solid support on the evaporation process is evaluated. It is shown that the lower the thermal conductivity of the solid substrate the higher is the deviation from the isothermal case. However, if the mean temperature of the droplet surface is used instead of the temperature of the surrounding air for the vapour concentration on the droplet surface then the calculated dependences coincide with those calculated for the isothermal case. We present a theory describing the evaporation of sessile water droplets in presence of contact angle hysteresis [2]. Theory describes two stages of evaporation process: (I) evaporation with a constant radius of the droplet base; and (II) evaporation with constant contact angle. During stage (I) the contact angles decreases from static advancing contact angle to static receding contact angle, during stage (II) the contact angle remains equal to the static receding contact angle. Predicted universal dependences curves are validated against available in the literature experimental data.

First stage of evaporation  Second stage of evaporation
Solid lines are predicted universal dependences [2]. Experimental points from various literature sources.