AN INFLUENCE OF DIFFERENCE OF SURFACE PROPERTIES ON AXISYMMETRIC VIBRATIONS OF AN OBLATE DROP IN AN AC FIELD

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Our work continues a series of papers devoted to the study of electrowetting-on-dielectric (EWOD) [1,2]. We are considering the forced oscillations of the incompressible fluid drop under the action of the non-uniform electric field. This electric field acts as an external force that causes motion of the contact line. The equilibrium form of drop has the form of a cylinder bounded axially by the parallel solid planes and the contact angle is right. We investigate the case of different uniform plates as district from other works [1,2], i.e. the plates have different surface (wetting etc.) properties. In order to describe this contact line motion, the modified Hocking boundary condition [3] is applied: the velocity of the contact line is proportional to the deviation of the contact angle and the speed of the fast relaxation processes, whose frequency is proportional to twice the frequency of the electric field [1,2]. The proportionality coefficient (Hocking's parameter) for each surface is different. This condition leads to damping of the oscillations, which is explained by the interaction of the contact line with a solid surface.

The solution of the problem is written as a Fourier series in eigenfunctions of the Laplace operator. The resulting system of heterogeneous equations for unknown amplitudes was solved numerically.

It is shown that, firstly, the even and odd modes spatial modes exist because of different plates. Secondly, the heterogeneity of the electric field leads to the excitation of azimuth modes.

Amplitude-frequency characteristics are plotted for different values of the parameters of the problem. For small values of the Hocking parameter, i.e. with strong interaction energy between the contact line and plate, the oscillations amplitude is small. In opposite case, the resonance amplitude of the surface forced oscillations is large and tends to infinity in the limit of fixed contact angle. Also the dynamic forms of the drop were calculated.

The deviations of the contact angle as a function of the square root of the effective amplitude are given for different Hocking parameter and field frequency. The responses obtained qualitatively agree with the experimental data.

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References

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