

Prewetting transition in electric field gradients

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We describe a class of phase transitions occurring in systems under spatially varying electric fields. In a mixture of liquids the coupling of the field to the dielectric constant can lead to a demixing transition if the external potential is large enough (and similar changes occur in the liquid-vapour coexistence curve of pure fluids). The demixing due to long-range electrostatic forces depends sensitively on the geometry of the system. A spinodal-like line governs the dynamical behaviour.

Two main time scales characterize the non-equilibrium interface behavior: (1) the lag time t_L for forming an interface, and (2) the relaxation time to equilibrium. We find that t_L increases as parameters (temperature, bulk composition, and surface charge) approach the electrostatic spinodal line in the phase diagram. Close to this line, t_L is proportional to a renormalized bulk concentration with an exponent of 1.16 ± 0.03 .

In addition to the dielectric anisotropy, existence of a finite conductivity leads to appearance of large stresses when these systems are subject to external fields and usually to a reduction in the voltages required for the instabilities or phase transitions to occur. Predictions for thermodynamic equilibrium will be presented for polar liquids containing dissociated ions.

This electro-prewetting transition is believed to play an important role in inter-surface forces.

For example, colloidal stabilization in liquid mixtures without use of surfactants or polymers can be achieved. When a suitable salt is added to a solvent mixture, the coupling of the colloids surface chemistry and the preferential solvation of ions leads to a repulsive force between colloids that can overcome van der Waals attraction. This repulsive force is substantial in a large range of temperatures, mixture composition, and salt concentrations. The increased repulsion due to addition of salt occurs even for charged colloids. This mechanism may be useful in experimental situations where steric stabilization with surfactants or polymers is undesired.

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[3] Y. Tsori, *Rev. Mod. Phys.* **81**, 1471 (2009).