33a Micro- and Nano-Scale Flow Instabilities during the Approach and Detachment of Liquid and Polymer Surfaces

Jacob N. Israelachvili, Matthew V. Tirrell, Nobuo Maeda, Nianhuan Chen, and Hongbo Zeng

Using the Surface Forces Apparatus and the 'FECO' optical interference technique which allows one to observe surface deformations at the nano scale during intermolecular and surface interactions, we have measured the deformation of both liquid and polymer surfaces during their approach, coalescence and subsequent separation from adhesive contact. Both non-equilibrium (constant volume) and equilibrium (constant chemical potential) conditions were studied. In the case of viscoelastic polymer surfaces, especially near Tg or in the glassy state, interesting deformations occur at different length and time scales, including molecular interdiffusion, surface rippling and fingering, and cavitation. These will be described and illustrated with video recordings of deforming surfaces as visualized via deforming 'FECO' fringes. These deformations are in turn related to deviations from equilibrium values of measured surface energies and adhesion forces between such surfaces, and to energy-dissipating processes that give rise to complex viscous, hydrodynamic, lubrication and friction forces.