First Experimental Proof of the Nonexistence of Long-Range Hydrophobic Attraction Forces in Thin Wetting Films

By Klaus Werner Stöckelhuber, Hans Joachim Schulze, and Andreas Wenger*

Dedicated to Professor Walter Nitsch on the occasion of his retirement from the chair of Technical Chemistry at the Munich University of Technology

1 Problem

In several cases of coagulation phenomena the classical DLVO theory does not seem to fit. Therefore, the so-called long-range hydrophobic attraction forces (LRHF) had been postulated. A well-known example is the adhesion of solid particles to gas bubbles during flotation. The crucial elementary step in this heterocoagulation process is the thinning and the rupture of the thin liquid wetting film between particle and bubble. In most cases (e.g., in the commonly used quartz/water/air system) both components the electrostatic forces as well as the van der Waals interaction forces are repulsive. Therefore, these thin liquid films should be stable and an attachment of the particle to the bubble should be prevented. But in the case of a hydrophobized particle surface a different effect occurs. In order to solve this contradiction, in the last few years several authors assumed the existence of LRHF [e.g. 1,2]. A recent work of Ninham [3] could show that phenomena explained with the existence of LRHF can be explained in another way and according to classical physical theories.

In this article we could show experimentally for the first time that thinning, destabilization and rupture of such wetting films on hydrophobic silica surfaces are not caused by long-range hydrophobic attraction forces at all [4]. On the contrary, thinning and drainage are explainable by the DLVO theory and the well-known Reynolds equation. The cause of the rupture of these thin films are processes of nucleation which are not driven by any attraction forces.

[*] Dr. rer. nat. K. W. Stöckelhuber, Dr. sc. nat. H. J. Schulze, Dipl.-Chem. A. Wenger, Research Group Colloids & Interfaces, Institute of Ceramics Engineering, Freiberg University of Technology and Mining, D-09599 Freiberg, Germany.