Aqueous Foams Stabilised by Nanoparticle-Surfactant Mixtures

Bernard P. Binks and Jhonny A. Rodrigues

Surfactant & Colloid Group, Department of Chemistry, University of Hull, Hull. HU6 7RX. UK

Using a range of complementary experiments, a detailed investigation into the behaviour of air-in-water foams stabilised by a mixture of silica nanoparticles and pure cationic surfactant has been made. At high pH where both particles and surfactant molecules are highly charged, no foam is possible with particles alone whereas surfactant-stabilised foams break down completely within one day at all concentrations. In particle-surfactant mixtures, a synergism occurs with respect to foam formation and stability due to the adsorption of surfactant molecules onto particle surfaces. The foamability of mixed dispersions is substantially reduced compared with surfactant solutions alone. However, the foam stability passes through a maximum with respect to surfactant concentration and these foams are remarkably stable. Based on findings from dispersion stability measurements, particle zeta potentials, the adsorption isotherm of surfactant on particles and relevant contact angles of water in air on silica surfaces, we conclude that foams are most stable when particles are strongly flocculated corresponding to them possessing a low charge, being maximally hydrophobic and containing an adsorbed monolayer of surfactant. Cryo-SEM analysis of the same foams leads us to propose that foam stabilisation changes from being surfactant dominated at low surfactant concentration to being particle dominated at intermediate concentrations and reverting to surfactant dominated at higher concentrations.