CLOGGING OF MICROCHANNELS BY NANOPARTICLES DUE TO HETEROCOAGULATION IN ELONGATIONAL FLOW

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We have investigated the phenomenon of flow-induced aggregation in highly concentrated colloidal dispersions exposed to strongly converging flow fields. This phenomenon is relevant not only for classical technical operations like coating, pumping or filtration, but also for the application of concentrated suspensions in upcoming processing technologies based on microfluidic devices. A ring-slit device (Figure1), which allows for a variation of flow kinematics in a wide range, has been developed in order to investigate this phenomenon.

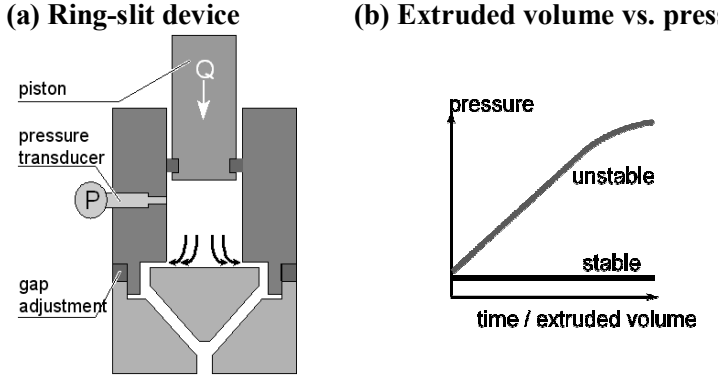

Figure 1. *Ring-slit device (a), pressure development for stable and unstable samples (b)*

Various polymer dispersions with different particle surface properties have been used as model systems. Our experiments exclude, that channel clogging is due to retention of pre-existing aggregates, fouling or hydrodynamic bridging. Instead, we demonstrate that clogging of the microchannel is induced by hetero-coagulation between primary colloidal particles and micron-sized impurities present at concentrations on the order of 100 – 1000 ppm. Clogging can occur even if the diameter of these impurities is less than a tenth of the gap height. Aggregation takes place in the converging flow field at the channel entrance, but not in the shear field within the slit. It can be suppressed by appropriate stabilization of the primary particles.

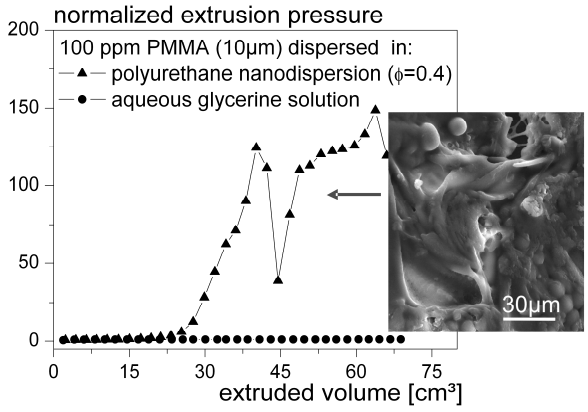

Figure 2. *Effect of 10 µm PMMA particles on the flow-induced aggregation of a concentrated polyurethane nanodispersion at 100 ppm PMMA. (slt height = 21µm)*