Bubble microrheology

A new approach to extensional viscoelastic measurements

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bulk density on the stress is assumed (low stress values) and Janssen equation is consequently integrated analytically. Polyethylene powders for rotomolding were uniaxially compressed and their average bulk density values at different column heights and different stresses were modelled with the modified Janssen equation. This procedure allowed to work out reasonable values for the wall friction angle and the lateral stress ratio K in addition to the linear constitutive equation parameters describing the stress dependence of the bulk density.

Thursday 15:20 Kronborg PG17

An insight into time - dependent consolidation with shear testing approach

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Handling of powders is crucial for several industries whenever particulate systems are the starting point for any step of the whole production chain. Different industries also face similar challenges while working with different powders. Among those, flowability and cake formation during storage are the two most common challenges. The aim of this study was to explain mechanisms for powder caking by, first, inducing caking through controlling storage conditions and second, applying a consolidation pressure as a function of time. In this study, samples were stored at relative humidities of 54 %, 75 % and 95 %. The powder consolidation was performed by applying a pressure over an external consolidation bench. Powder flowability was analyzed using a ring shear tester (Schulze RST-Xs). The yield locus of the sample (without consolidation) was analyzed using a pre-shear of 2000 Pa. To analyze the flowability after consolidation for a defined time, the samples were pre-sheared in the ring shear tester and defined stress (3500 Pa) was applied externally. Afterwards, the shear cell was placed back on the ring shear tester and the shear stress under the lowest normal stress was obtained. By comparing this value with the obtained value from the flowability measurement of the same powder sample, effects of time consolidation pressure and storage induced caking could be quantified. A pharmaceutical grade lactose (spray dried a-lactose monohydrate; FlowLac 100, Meggle, Germany) was chosen as a model compound. This lactose was partially crystalline and adsorbed small amount of water (0.2 %) at a relative humidity of 90 %. A significant decrease in flowability between storage at 50 % RH (ffc=10.0) and 90 % RH (ffc=8.3) was observed. Furthermore, 90 min of consolidation led to a significant decrease in flowability. The preliminary data suggest that the approach adopted in this work is capable of quantifying powder caking. Thus, it can be used to investigate caking propensity of a number of fine chemical powders during storage.

Symposium MN

Micro and nanorheology, microfluidics

Organizers: Eric M. Furst and Anke Lindner

Thursday 15:00 Schackenborg MN22

Bubble Microrheology: A new approach to extensional viscoelastic measurements

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Information on the viscoelastic response to extensional deformation of polymeric solutions and other complex fluids is crucial for understanding their behavior in a wide variety of industrial applications. While the characterization of complex fluids using simple shear experiments is well established, a complete characterization of their extensional rheological properties is still challenging. Currently, methods such as CaBER, ROJER, and microfluidics are used for this. The downside of these techniques is that fluids with low viscosity and/or short relaxation times are still hard to characterize.

Here we propose an alternative approach for measuring extensional rheological properties by using a microscopic air bubble as an extensional rheometer. We pursue this idea experimentally by submerging a single bubble in a pool of liquid and studying the dynamics of the bubble under influence of a change in hydrostatic pressure. This situation is analogous to a stress-controlled shear rheology experiment, where a time-dependent shear stress is applied to a sample and the resultant strain is measured. We test our approach on a range of polymeric fluids with different relaxation times and find that the bubble microrheology experiments provide results and trends that are indeed consistent with theoretical expectations and with previous data acquired using established methods. The concept of bubble microrheology is thus very promising. While the experimental technique is straightforward, practical improvements can still be made on the experimental setup and the data analysis, which could extend the range of investigable materials and the amount of information that can be extracted from the measurements. A chief advantage of our methodology is that it ensures the measurement of only extensional properties and that fluids with very short relaxation times can be measured. Finally, by applying a sinusoidal pressure variation instead of a pressure jump, our method could potentially be extended to oscillatory measurements.

Thursday 15:20 Schackenborg MN23

Viscosity of protein solutions measured with dynamic light scattering using inert tracer particles

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Protein solutions often show a sudden viscosity increase at a certain threshold concentration, which depends on the type of protein as well as on solvent conditions. The location of this liquid-solid transition is currently hard to predict using information solely obtained from