ADVANCED POLYMER RHEOLOGY BASED ON RHEO-OPTICAL TOOLS AND A DUAL MOTOR DEVICE

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The simultaneous application of rheological and optical techniques leads to a better understanding of the dependencies between the microstructure and the mechanical properties of complex fluids and especially polymeric materials. Various optical methods such as small angle light scattering, microscopy (polarized, fluorescence, confocal), spectroscopy (NIR, IR, Raman), birefringence and dichroism have been used. A rheo polarized imaging techniques (SIPLI - shear induced polarization light imaging) which measures local stresses by detecting birefringence and Raman spectroscopy are discussed in more detail. By using a parallel-plate geometry with SIPLI, the entire measuring plate is observed and the birefringence can be visualized over the full range of shear rates in a single experiment. To directly relate changes in rheological behavior to chemical changes or phase transition, Raman spectroscopy can be used in situ with rheology.

A rheometer platform based on a combined motor transducer (CMT) rheometer with an electrically commutated synchronous motor on the upper side allows the use of a second motor on the bottom side. The second motor could either be a rotational or a linear drive. When a rotational drive is used, the instrument becomes a separate motor transducer (SMT) rheometer by using one motor as drive and the second as a torque transducer. In addition, the instrument can be operated in a counter-rotation mode where both motors rotate in opposite directions, allowing the creation of a stagnation line in the sample where it is sheared but not moved from its position for rheo-microscopy. The SMT mode has some advantages in terms of sensitivity under certain measurement conditions and allows the use of special tools such as a cone-partitioned-plate (CPP), which allows measurements to be made even when edge fracture would hinder them in standard geometries. Combining the upper rotational motor with a linear drive in the bottom enables new testing possibilities. By using only the linear drive, Dynamic Mechanical Analysis (DMA) is possible on more solid specimens with different geometries like tension, three-point bending, cantilever, or in compression. When using a solid bars geometry, DMA in tension by the linear drive and DMA in torsion with the upper rotational drive are possible on the same specimen, allowing to extract not only the DMA parameters but Poisson's ratio to be determined.

The fast response of the linear motor can be used in combination with a fast visualization setup for capillary breakup rheometry.