Surface Light Scattering for the Accurate Determination of Viscosity and Interfacial Tension of Non-Transparent Systems

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Surface light scattering (SLS) represents an established method to determine viscosity and interfacial tension of fluids at thermodynamic equilibrium. This is possible by analyzing thermal fluctuations at phase boundaries whose dynamics is reflected by the temporal behavior of the scattered light intensity. For transparent fluids, it is advantageous to analyze the scattered light in transmission direction. For non-transparent fluids, the scattered light can only be detected in reflection direction, which implies further experimental challenges. Compared to a detection scheme in transmission direction, the scattered light intensity is lower for one in reflection direction. Furthermore, for suppressing laser heating effects on non-transparent fluids, small laser powers have to be applied, which results in even weaker scattering signals. To compensate this, small wave vectors of surface fluctuations need to be probed, whereby instrumental line broadening effects can occur. If not considered in data evaluation, these effects may cause erroneous results for viscosity and interfacial tension.

The main aim of this contribution is to probe the applicability of SLS for an accurate determination of viscosity and interfacial tension of non-transparent fluids. First, transparent fluids are investigated probing relatively large wave numbers, where line broadening effects are negligible. Here, the optical arrangement is validated by checking the measured viscosities and interfacial tensions against reference data. Then, the same fluids are studied under much smaller wave vectors for evaluating the instrumental line broadening of the detected signals. In this context, also the performance of the detection schemes analyzing the scattered light perpendicular and non-perpendicular to the fluid interface is assessed. Finally, selected non-transparent fluids are investigated applying small wave vectors. Considering line broadening effects on the measurement signals, viscosity and interfacial tension can be accurately determined. To test the suggested approach, results obtained from SLS in transmission direction and conventional methods are used for comparison.