Viscosity Measurement by Dynamic Light Scattering

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For the existing dynamic light scattering (DLS) method for measuring the viscosity of liquid, the relative measurement method must be applied and the collective translational diffusion coefficients and the hydrodynamic diameter of probe particles in the standard liquid and sample must be measured successively. Then the viscosity of the sample can be obtained. However, the hydrodynamic diameter of probe particles in the standard liquid is not equal to that of the sample, which introduced a principle defect into the existing method. In this work, the one-parameter models were introduced to establish the linear relation among the collective translational diffusion coefficients, the hydrodynamic diameter, and the concentration of probe particles. The current measurement principle of DLS method for measuring the viscosity was modified and an improved measuring method is proposed, which is able to measure the viscosity directly and eliminate the uncertainty of particle size caused by relative measurement. Based on the modified method, the experimental apparatus has been established and the photon correlation technique was employed to obtain the collective translational diffusion coefficient of the probe particles in the sample. The relative combined standard uncertainty in viscosity was estimated to be 0.018. At 293.15 K and atmospheric pressure, the viscosity of water and ethanol were measured with polystyrene latex (200 nm) and silica (200 nm) as the probe particles, respectively. The experimental dynamic viscosity of water and alcohol are equal to 1.009 mPa·s and 1.177 mPa·s, respectively. Compared with the literature data, the absolute average of relative deviations (AARDs) are 0.63 % for water and 0.40 % for alcohol. The results agree well with the literature data. So the improvement of the measuring principle and the reliability of the experimental setup were verified.