Study of Viscosity Measurement for Non-Newtonian Fluid by Laser-induced Capillary Wave Method- Experiment with Frequency Domain Approach

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The purpose of the present study is to establish a theory applicable to Newtonian fluids and non-Newtonian fluids by the Laser-induced Capillary Wave (LiCW) Method. In the present paper, we proposed the new viscosity measurement technique applicable to Newtonian and non-Newtonian fluids, which consists of Navier-Stokes equation and continuity equation with negligible effect of heat conduction. The theory provided us the viscosity calculating by measuring center frequency *w* and damping rate G with Fourier-transformed spectrum of wave amplitude $u_z(t)$.With this theory, we demonstrated the measurement of Newtonian fluid samples (satisfied with negligible effect of heat conduction) with various observed wavelength of LiCW to verify the applicability of this theory quantitatively. The results indicated that we successfully measured the absolute values of viscosity within the reference deviation of -5 ～ -10 % for wide wavelength range of LiCW 30～100 mm. Therefore, we found that low viscosity range (10^{-1}～10^{0} mPa・s order) samples were able to apply the theory. Additionally, we evaluated the appropriate fringe space for measurement of non-Newtonian fluids from the results. Finally, we improved the new theory to apply to non-Newtonian fluids by employing power law model. We demonstrated the applicability of the improved theory by comparing between theoretical values and measured values for center frequency *w* and damping rate G of power law fluid samples (PTB reference samples: NNRF2 and NNTF1).