Application of Pulsed Laser Viscometer to Measure Viscosity of 2 ml of Whole Human Blood and Plasma within 1 ms at 37 °C

Takehiro Kobayashi [C, S]
School of Integrated Design Engineering, Keio University, Yokohama, Kanagawa, Japan
kobayashi@naga.sd.keio.ac.jp

Yuji Nagasaka
Department of System Design Engineering, Keio University, Yokohama, Kanagawa, Japan

Identifying elevated blood viscosity is of clinical importance since it indicates increased flow resistance and abnormal flow dynamics. However, conventional viscometers are not appropriate for use in the medical field, because they take a long time to measure viscosity, require large sample volume of blood, and have contact with blood sample. Accounting for these problems, we have developed a Pulsed Laser Viscometer (PLV), which is capable of non-contact, high-speed, and continuous sensing of liquid viscosity with micro-liter sample volume. PLV is a viscometer which measures viscosity by sensing the damping behavior of capillary waves on liquid surface induced by a pulsed heating laser (near-infrared laser: wavelength 1064 nm).

The goal of our research is to measure viscosity of whole human blood and plasma within 1 ms exactly at 37 °C by using PLV. In this paper, we performed an experimental study to determine appropriate experimental parameters, and measured viscosity of whole human blood and plasma at 37 °C. Firstly, we verified the damping behavior of temperature gradient at blood surface induced by pulsed heating laser to determine oscillation period of heating laser. As a method, we observed the temperature change of 2 ml of blood surface by using thermography. As a result, we verified that the oscillation period of the heating laser must be longer than 30 s. Secondary, we introduced a new sample stage, which can keep the blood sample at 37 °C. After that, we measured viscosity of 2 ml of whole human blood and plasma obtained from a healthy man at 37 °C.