The Use of Photothermal Infrared Radiometry for Thermal Studies on Liquid Samples

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During the past decades, PTIR is renowned in its non-invasive ability of finding thermal parameters of solid samples. Until now only a few researchers have essayed in regard to its ability to examine the thermal properties of liquids. Usually photopyroelectric (PPE) based measurements, which have an excellent signal to noise ratio in normal operation, are used for thermal measurements on liquids. Nevertheless, since it is a contact method, PPE fails in some situations, such as with chemically reactive materials, or in the presence of strong electric or magnetic fields that can induce extra noise in the signal. Also, it requires a sensor characterisation that has a greater impact on studies varying the temperature. These considerations led us to find a new methodology for characterising liquids using Photothermal Infrared Radiometry. In this work, we have developed a series of robust and high accuracy methods to characterise the thermal properties of liquid samples. We have used a three-layer model approach in which the sample liquid is sandwiched between a thermally thick CaF2 window on the top, and a glass substrate. Since CaF2 is transparent to both visible and NIR radiations (300nm-10µm), we have made an opaque coating at its bottom interface with the liquid sample that serves both as an IR emitter and absorber for the laser beam when irradiating from the top. This coating also protects the CaF2 window and allows space to make electrical contacts for studies varying the Electric Field. In total, we are presenting three configurations: so called *1) Front infrared radiometry, 2) Front-Rear infrared radiometry, and 3) Rear infrared radiometry,* to find the thermal diffusivity and thermal effusivity of liquid samples. Each of these methods is presented theoretically followed by experimental results with some practical applications. The sensitivity studies and included error analyses show the robustness of each method. Finally, studies on a 5CB liquid crystal in the nematic phase showing the thermal diffusivity and effusivity variations with electric field are presented.