

High Accuracy Values of Thermal Conductivity and Thermal Effusivity of Binary and Ionic Liquids by Photopyroelectric Method

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As in most techniques used to determine thermal properties, with the exception of those determining the thermal effusivity of semi-infinite samples, the absolute accuracy of the photopyroelectric (PPE) method is mainly dependent on the precise knowledge of the thickness of the sample. In most reported PPE implementations, the thickness of the sample layer in the 1D stacked photopyroelectric sandwich configuration was determined by performing and fitting a frequency scan of the amplitude and phase of the signal on a reference sample with known thermal properties. The obtained thickness value was then re-used as a known parameter for the analysis of the frequency dependence of the PPE signal obtained by replacing the reference material by the material of interest while keeping the configuration and thickness unchanged. Inspired by Caerels et al. [1], Mandelis et al. [2] and Delenclos et al. [3], we have made use of a precision translation stage to achieve precise thickness variations in a combined frequency and thickness scan approach, which avoids the need for a separate thickness calibration on the basis of a reference liquid. We will present the details of the method and illustrate its performance on a series of liquids by comparison with literature values, and by statistical analysis determining least squares and most squares fitting uncertainties on the extracted values. The high sensitivity of pyroelectric transducers allows for the detection of very small temperature variations, making the PPE method very suitable for thermal property determination near critical points with high temperature resolution [4,5,6]. We will illustrate this by recent results concerning the temperature dependence of the thermal properties near the consolute point of the binary mixture choline bistriflimide-water, and other binary mixtures of liquids.

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