Experimental Determination of Thermoelastic Constants for Liquids by Photoacoustic Calorimetry

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The amplitude of a photoacoustic signal in a liquid is directly proportional to the thermoelastic properties of the solvent. The ratio of the expansion coefficient (beta), to the product of compressibility (alpha), heat capacity (Cp) and density (rho) is referred to the solvent quality factor (Sp). A graph of calculated Sp values verses the observed photoacoustic signal amplitude shows a direct linear correlation for a series of organic solvents. From the linear correlation we can determine Sp for another solvent from the measured PA signal amplitude. Given the literature values for alpha, Cp and rho for THF we obtained an experimental measurement of beta, the thermal coefficient of expansion. To our knowledge there is no other measurement of this parameter. This experimental photoacoustic approach can provide a useful tool to measure thermoelastic properties of liquids when either the coefficients of expansion or compression are unknown. Knowledge of the thermoelastic properties in the various solvents permits a quantitative analysis of the molecular volume changes arising from photo-induced bond scission.