A Double-pass Optical Beam Deflection Instrument for the Measurement of Diffusion, Thermodiffusion and Soret Coefficients in Liquid Mixtures and its Application to Polymer Analysis

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The Soret effect in liquid mixtures and its utilization for the measurement of isothermal Fickian diffusion can be investigated experimentally by optical techniques. Typically, the procedure is such that a temperature gradient is formed within a multicomponent liquid and subsequent thermodiffusion induces a composition gradient that develops on a much slower time scale than neccessary for the establishment of the temperature field. The final asymptotic steady state is reached when thermodiffusion and Fickian diffusion balance each other. Using the optical beam deflection technique, a vertical temperature gradient is applied to the sample and information about the time-dependent distribution of temperature and concentration in the sample is gathered by recording the position of a laser beam, which traverses the sample and gets deflected. This is because the refractive index changes with temperature and concentration, which on its part changes due to thermodiffusion. We have developed a new double-pass optical beam deflection instrument for the measurement of diffusion, thermodiffusion and Soret coefficients in liquid mixtures. The increased sensitivity of the instrument results from a second passage of the readout laser beam through the Soret cell containing the sample. An elegant description of the total beam deflection is achieved by means of a transfer matrix formalism. The higher sensitivity allows for a reduction of the length of the detection arm and a compact and stiff design of the instrument. The performance of the new apparatus is demonstrated by its application to polymer analysis for the determination of the molar mass distribution of the polymer from the distribution of diffusion rates by means of the CONTIN algorithm.