Modification of a Brice-Phoenix Differential Refractometer Cell for Measurements of Highly Refractive Liquids

The refractive index increment is a quantity the knowledge of which is necessary for an evaluation of the light scattering measurements from dilute polymer solutions. The refractive index increment is determined in these cases as a fraction of the difference between the refractive indexes of the solution and the solvent (Δn) and a known concentration of the solute. As a rule, Δn is measured with a differential refractometer (less frequently with an interferometer). At present, the most commonly used type is the differential refractometer according to Brice and Halwer,[1] manufactured by the Phoenix Precision Instrument Company, Philadelphia.

The standard commercial cell is made of optical glass, refractive index $n \sim 1.52$. It can be used in measurements of liquids with $n < 1.62$, since at higher refractive indexes there is a total reflection of the beam on the inclined partition. The manufacturers offer a special cell which in a normal position allows measurements up to $n \leq 1.62$. If rotated by 90°, it can be used also for liquids with $n > 1.62$, but at the expense of reducing the sensitivity to one seventh of the original value.[2]

Lately, increased attention devoted to the study of the solution properties of copolymers has led to an increase in the use of highly refractive solvents (e.g., α-bromonaphthalene,[3,4] α-naphthyl methyl ether,[5] etc.). Measurements involving these highly refractive solvents have so far been performed with interferometers. In these measurements, however, considerable complications have often been observed, due to sudden shifts of interference fringes when the concentration of the solute is being increased (see, for example, Mächtle and Fischer[6]). These shifts are explained by differences in the dispersions of the refractive indexes of the solvent and the solute.

Therefore, a differential refractometric cell was made, geometrically identical with the original one, but with the inclined partition made of optical glass, refractive index $n = 1.62$, (type F620/363, Bohemia Glass, Czechoslovakia). In this case, the total reflection does not occur until the refractive index of the measured liquid $n = 1.73$ has been reached. To connect the parts of the cell, a synthetic organic glue was used, resistant to long-term action of all main solvent types.[7] The cell was calibrated with water solutions of potassium chloride as recommended by Brice and Halwer[1] and the manufacturer.[2] The sensitivity of measurements with this cell is the same as that of a commercial cell; the test measurements yielded refractive index increments identical with the values cited in the literature (Table I) and also with our own interferometric measurements.

TABLE I
Refractive Index Increments of Some Polymers in α-Bromonaphthalene

Polymer	dn/dc, ml/g (5461 Å)	
	Differential refractometer	Interferometer[a]
Polystyrene	-0.051_7	-0.051
Poly(methyl methacrylate)	-0.148	-0.147

[a] From Bushuk and Benoît.[3]

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