Temperature and Pressure Dependence of the Static Permittivity of N,N-Dimethylformamide and Dimethylsulfoxide

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Accurate values of the pressure and temperature dependence of the static permittivity (dielectric constant), ε, are of great scientific interest, since they are required for the application of various theories. For instance, the pressure dependence of ε needs to be known to model the compression of a solvent by the electric field of an ion via the Drude-Nernst equation,[1] or to apply the Debye-Hückel limiting law to heat capacities and volumetric properties.[2] However, studies of $\varepsilon(p,T)$ of molecular solvents in the literature are scarce.[3] A three-lobed re-entrant radio-frequency resonator with vacuum resonance frequencies of approximately (170, 675, and 1130) MHz has been used to measure $\varepsilon(p,T)$ for two common solvents *N,N*-dimethylformamide (DMF) and dimethylsulfoxide (DMSO). The permittivity was measured in the temperature range of 5 °C to 55 °C for DMF and 20 °C to 55 °C for DMSO in a pressure range of (1 to 50) bar. However, the first resonance frequency was below the low-frequency limit of the current instrumentation and the third one was overlapped by higher modes for the two solvents. Therefore $\varepsilon(p,T)$ was only accessible from the second mode at ~100 MHz. The third resonance was used to cross-check the $d\varepsilon/dp$ value.

[1] Drude, P.; Nernst, W. *Z. Phys. Chem.* **1894**, *15*, 79.
[2] Brouillette, D.; Perron, G.; Desnoyers, J. E. *J. Solution Chem.* **1998**, *27*, 151.
[3] Marcus, Y.; Hefter, G. *J. Solution Chem.* **1999**, *28*, 575