Comparative thermodynamic study exfoliated graphite nanoplatelets systems dispersed in dimethylformamide and water respectively, at 298 K

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Introduction

The thermodynamic study of binary systems containing exfoliated graphite nanoplatelets dispersed in N, N-dimethylformamide[1] and water respectively, is important for understanding the physicochemical behavior of liquid mixtures on basis analysis of chemicals with applications in the chemical industry. The acoustic and optical properties is considerable interest in extending the temperature range of thermodynamic data for mixture solutions.

Objectives

1. To report new experimental data for density, speed of sound and refractive index of the binary systems:
xGnP + DMF and **xGnP + H_2O**
at various concentrations of exfoliated graphite nanoplatelets (solute) and different quantities of N,N-Dimethylformamide and water (solvents) at T = 298.15 K.
2. To study the influence of the solvents on physicochemical behavior of exfoliated graphite nanoplatelets.
3. To calculated acoustic and optical parameters such as the acoustic impedance, adiabatic compressibility, specific refraction, space-filling factor, and relaxation strength were estimated with different equations from experimental density, speed of sound and refractive index results and volumetric.

Experimental

All chemicals used in this work were supplied by Merck and Fluka without further purification. The purity of these materials was > 99%. The densities and speed of sounds was measured with an Anton Paar DSA 5000 digital analyzer with a precision ± 10^{-6} g·cm^{-3}. Refractive index, were obtained using an Anton Paar Abbe automatic refractometer with a precision of ± 10^{-6}.

Equations

- 1. Acoustic impedance (*Z*): $$Z = \rho \; c$$
- 2. Isentropic compressibility coefficient (k_S): $$k_S = \frac{1}{K} = \frac{1}{\rho c^2}$$
- 3. Space-filling factor (S): $$S = \frac{B}{V} = \frac{n_D^2 - 1}{n_D^2 + 2}$$
- 4. Specific refraction (r_D): $$r_D = \frac{n_D^2 - 1}{n_D^2 + 2}\frac{1}{\rho}$$
- 5. Relaxation strength (*r*): $$r = 1 - \frac{c^2}{c_{ct}^2}$$
c_{ct} = constant = 1600 m·s^{-1},[2]
- 6. Correlated by a polynomial type equation: $$F(Y) = \sum_{i=1}^{n} A_i \, C^{i-1}$$
- 7. Absolute average percentage deviation: $$AAD(Y) = \frac{100}{N}\sum_{i}^{n}\left|\frac{Y_{Expt.} - Y_{Calc.}}{Y_{Expt.}}\right|$$

RESULTS

In this study the both experimental and calculated values for different physicochemical properties were obtained for binary systems xGnP+DMF and xGnP + water. These were analyzed and represented compared versus the concentration of solute at *T/K*= 298.15.
The symbols used in all figures are ■ for **xGnP + H_2O**; ▲ for **xGnP + DMF**; —, polynomial correlated values.

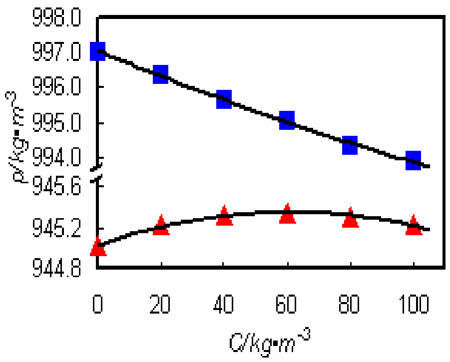

Fig.1. The density of binary xGnP + H_2O/DMF systems versus C/kg·m^{-3} of the xGnP.

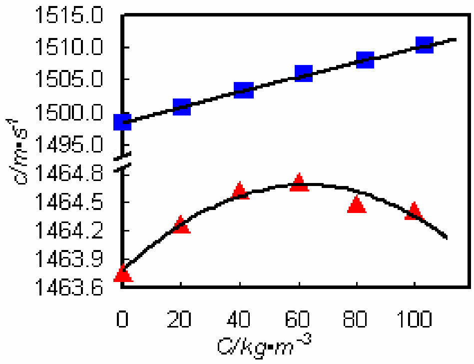

Fig.2.The speed of sound of binary xGnP + H_2O/DMF systems versus C/kg·m^{-3} of the xGnP.

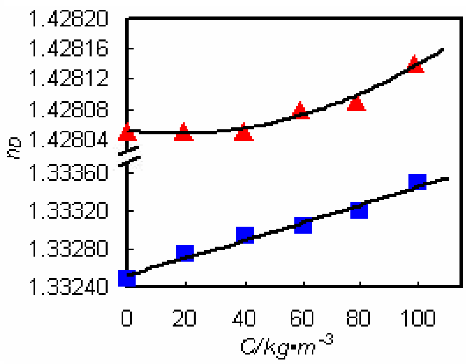

Fig.3. The refractive index of binary xGnP + H_2O/DMF systems versus C/kg·m^{-3} of the xGnP.

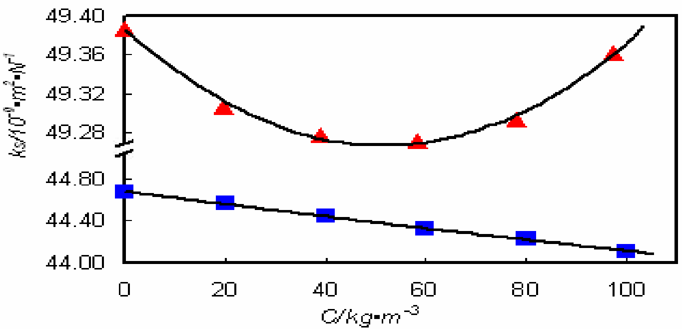

Fig.4. The isentropic compressibility of binary xGnP + H_2O/DMF systems versus C/kg·m^{-3} of the xGnP.

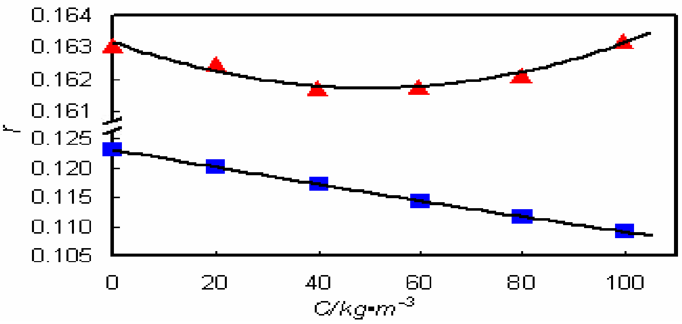

Fig.5. The relaxation strength of binary xGnP + H_2O/DMF systems versus C/kg·m^{-3} of the xGnP.

Conclusions: In the present investigation, the thermodynamic properties for binary systems xGnP+DMF and xGnP+H_2O were obtained. The results indicated that the studied parameters depend on the composition of the mixture, which is indicative of the presence of molecular interactions. A comparison between the two studied systems with exfoliated graphite nanoplatelets and solvents show that the values of the absolute percentage deviations are comparable and are less than (0.003, 0.005, 0.01, and 0.100) %, respectively for the calculated properties.

References

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2. Venkateswara R. A.; Raman G. K.; Varada R. A. Acoustical parameters of polystyrene in binary mixture. Asian J. Chem. 1993, 5, 582−592.