EMERGEMAT

8th INTERNATIONAL CONFERENCE
EMERGING TECHNOLOGIES IN MATERIALS ENGINEERING
06-07 October 2025, Bucharest, ROMANIA

THERMO-ACOUSTICAL AND OPTICAL INVESTIGATIONS OF BINARY AND TERNARY POLYETHYLENE GLYCOL 20000+DIMETHYLFORMAMIDE+DIMETHYLACETAMIDE MIXTURES, AT 298.15 K, WITH APPLICATIONS IN INDUSTRIAL PROCESSES

F. SIRBU[1], A.C. ION[2], C.S. STOICESCU[1]*, D. DRAGOESCU[1], I.L. GHEORGHE[1], A. STEFANIU[3], and I. ION[2]

[1]Ilie Murgulescu- Institute of Physical Chemistry of Romanian Academy, Department of Chemical Thermodynamics, 202 Splaiul Independentei, 060021, Bucharest, Romania, cristina.silvia.stoicescu@gmail.com
[2]National University of Science and Technology Politehnica Bucharest, Department of Analytical Chemistry and Environmental Engineering, Bucharest, Romania
[3]National Institute for Chemical - Pharmaceutical Research and Development – ICCF Bucharest, Romania

ABSTRACT

- The thermo-acoustical and optical properties for the binary and ternary mixtures of (polyethylene glycol 20000 + dimethylformamide) and dimethylacetamide, as well as their, have been measured at atmospheric pressure and different temperatures, from (298.15 up to 318.15) K.
- The properties as densities, speed of sound, and refractive indices, respectively were measured and reported in this paper, at T = (298.15 and 308.15) K. From experimental results, the derived properties, such as apparent molar volumes, the isentropic compressibility, and molar refractions have been computed with a good accuracy.
- The thermodynamic properties of polyethylene glycol 20000 in dimethylformamide and dimethylacetamide mixtures are discussed in terms of interactions, such as the hydration/dehydration effect of the solvent on the polymer.

METHODS and RESULTS

- ✓ The density and speed of sound of binary mixtures with and without TCC, were measured with an Anton Paar DSA 5000 digital (Austria) analyzer with a precision of ± 0.000001 g·cm^{-3}.
- ✓ The refractive indices were measured using an Anton Paar GmbH Abbe automatic refractometer with a precision of ± 0.000001, and the temperature of the samples was controlled within ± 0.01 K.
- ✓ The apparent molar volume ($V\varphi$) was computed from density data using the following relation:

$$V_{\Phi} = \frac{M}{d} + \frac{1000(d^0 - d)}{dd^0 m_A}$$

- ✓ The isentropic compressibility coefficient (β_T): $\beta_T = 1/(\rho \cdot u^2)$
- ✓ The molar refractivity (R_D), has been calculated with The Lorentz-Lorentz equation:

$$R_D = \left[\left(n_D^2 - 1\right)/\left(\left(n_D^2 + 2\right)\right)\right]\left(\sum_{i=1}^{3} x_i M_i / d\right)$$

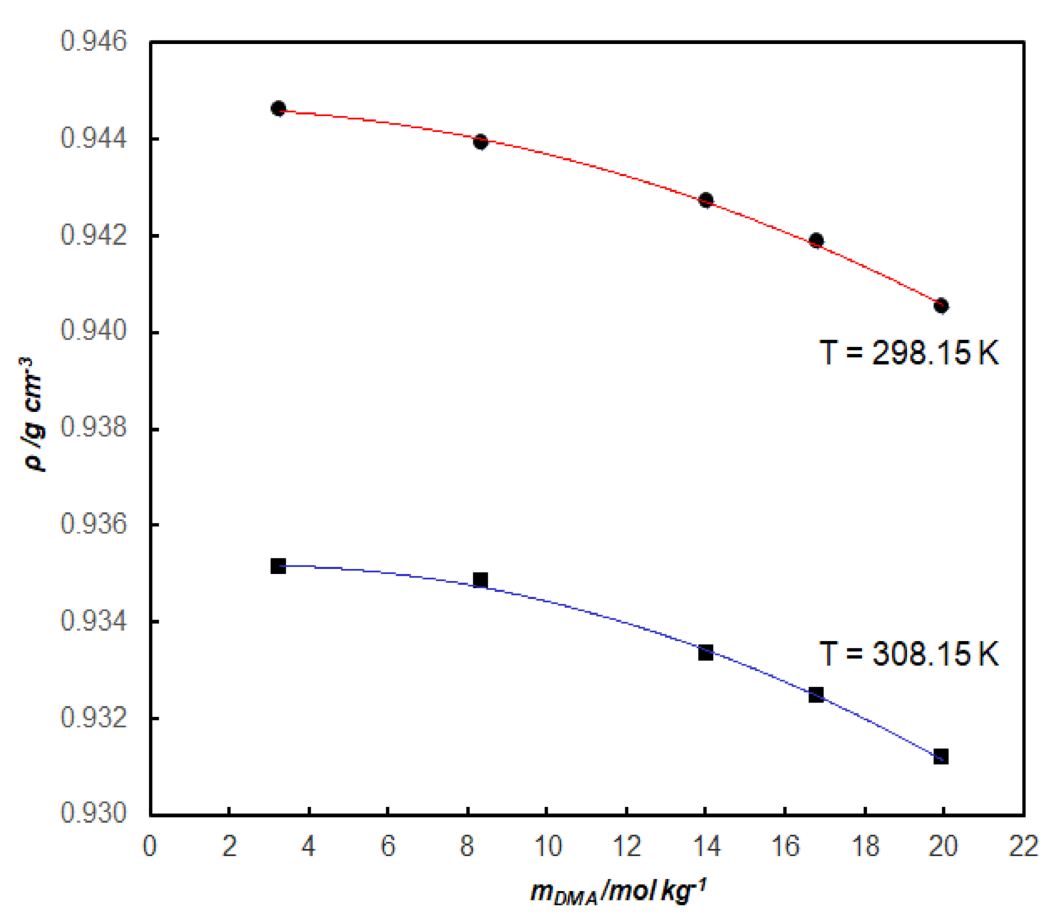

Fig.1. The experimental The **density** data in ternary DMA-PEG20000-DMF mixture versus m_{DMA} mol kg^{-1} of the DMA at (298.15 and 308.15) K.

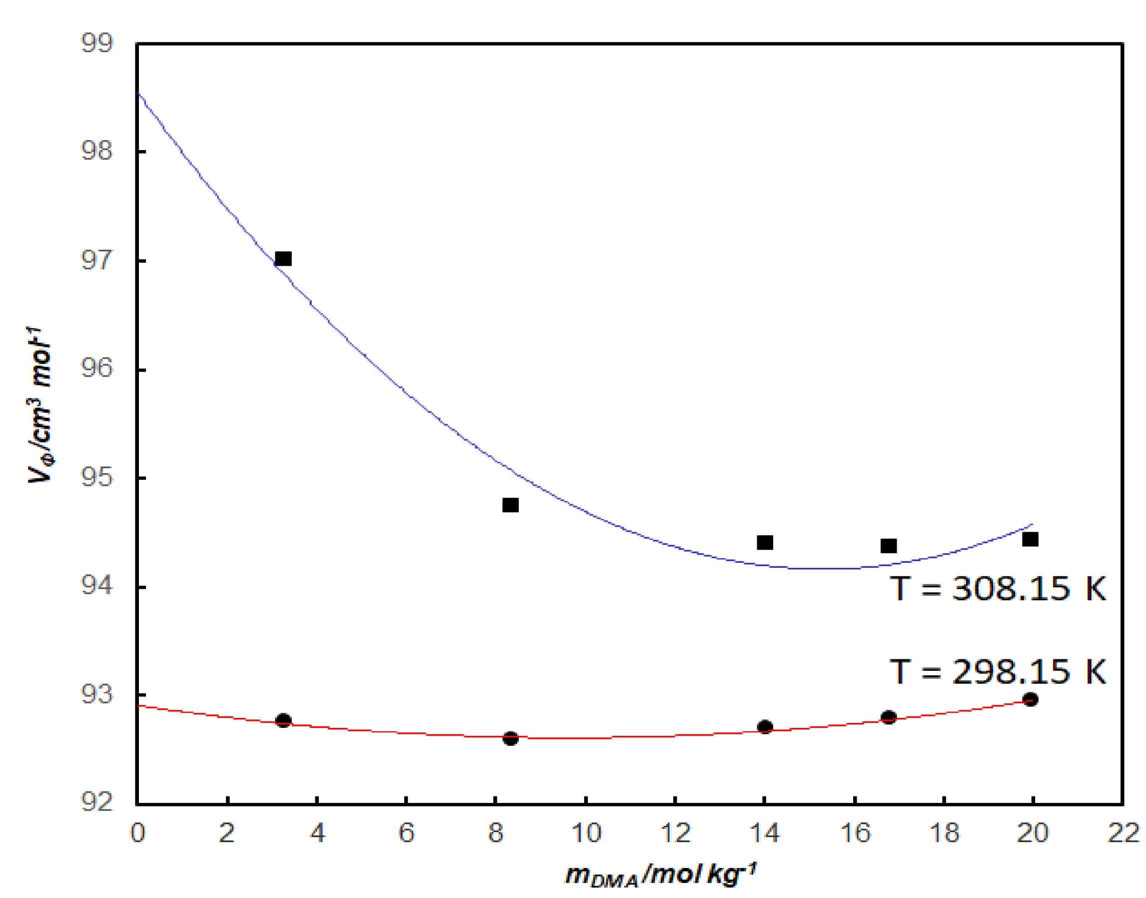

Fig.2. The *apparent molar volume* values in ternary DMA-PEG20000-DMF mixture versus m_{DMA} mol kg^{-1} of the DMA at (298.15 and 308.15) K.

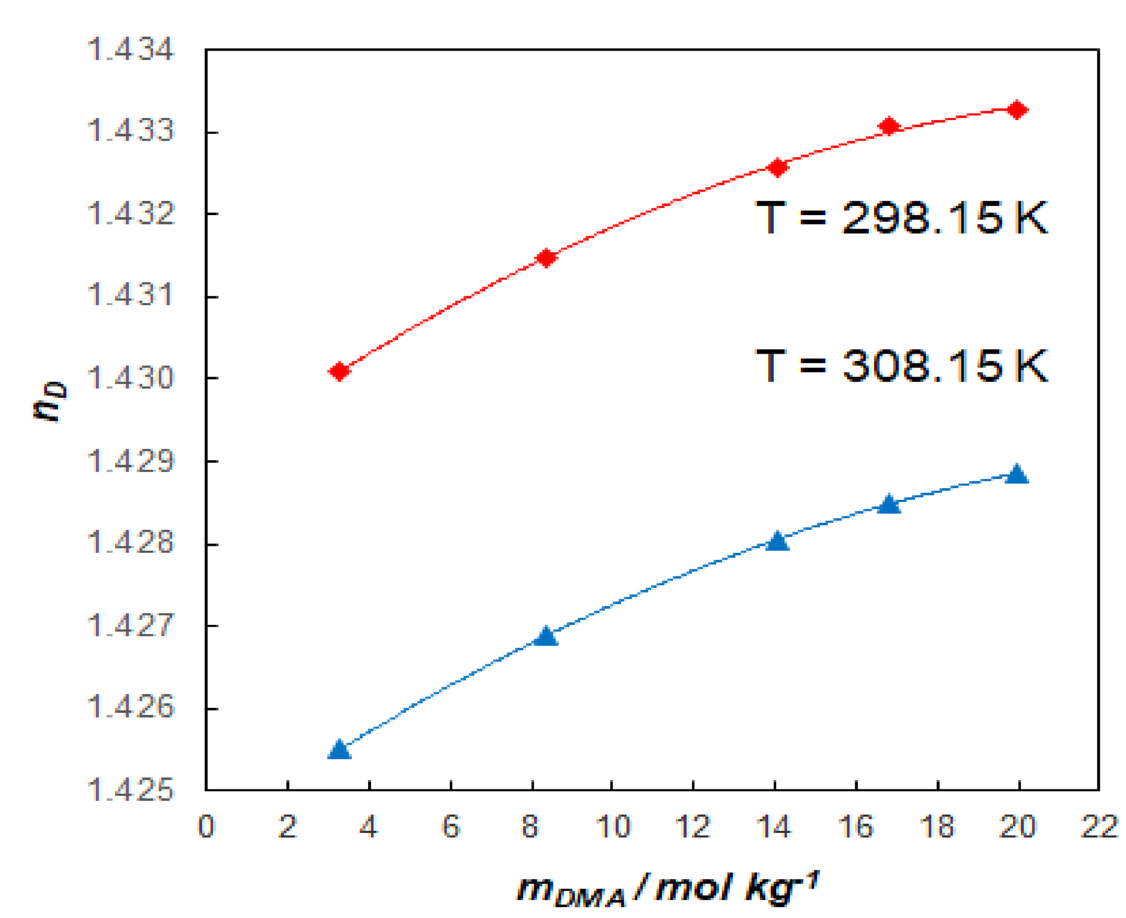

Fig.5. The experimental *refractive index data* in ternary DMA-PEG20000-DMF mixture versus m_{DMA} mol kg^{-1} of the DMA at (298.15 and 308.15) K.

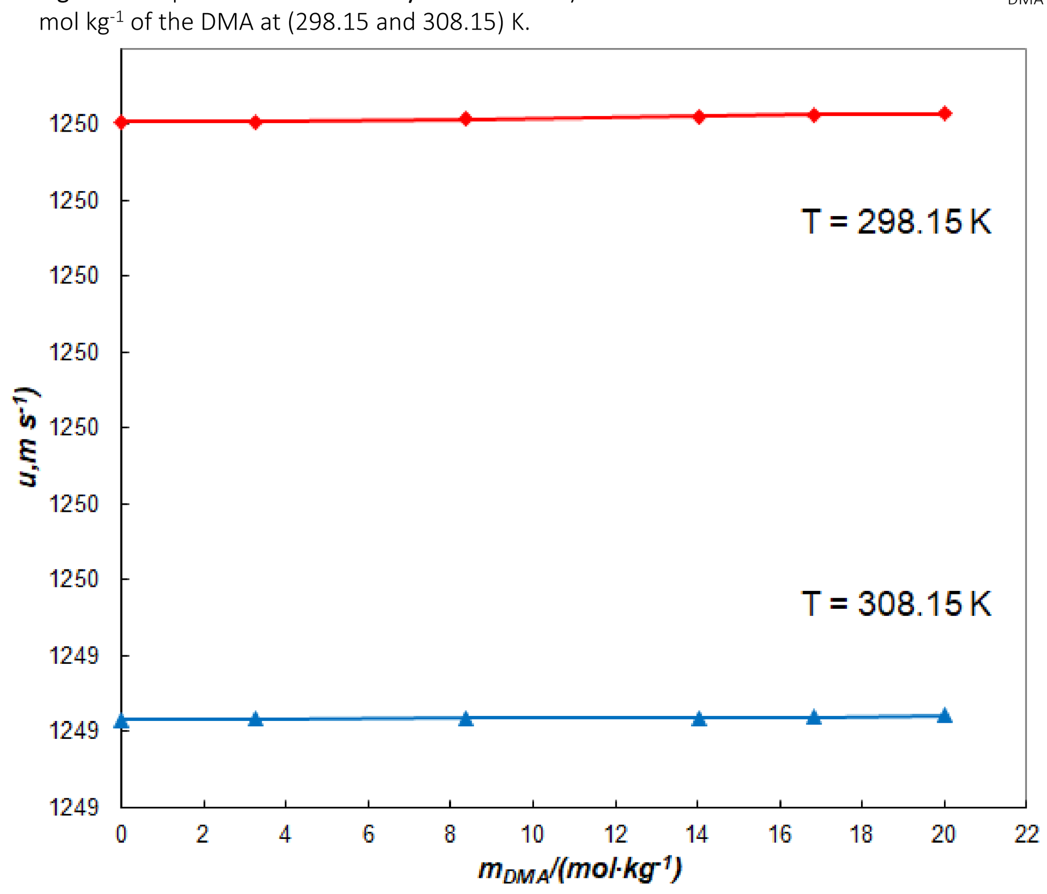

Fig.3. The experimental **speed of sound** data in ternary DMA-PEG20000-DMF mixture versus m_{DMA} mol kg^{-1} of the DMA at (298.15 and 308.15) K.

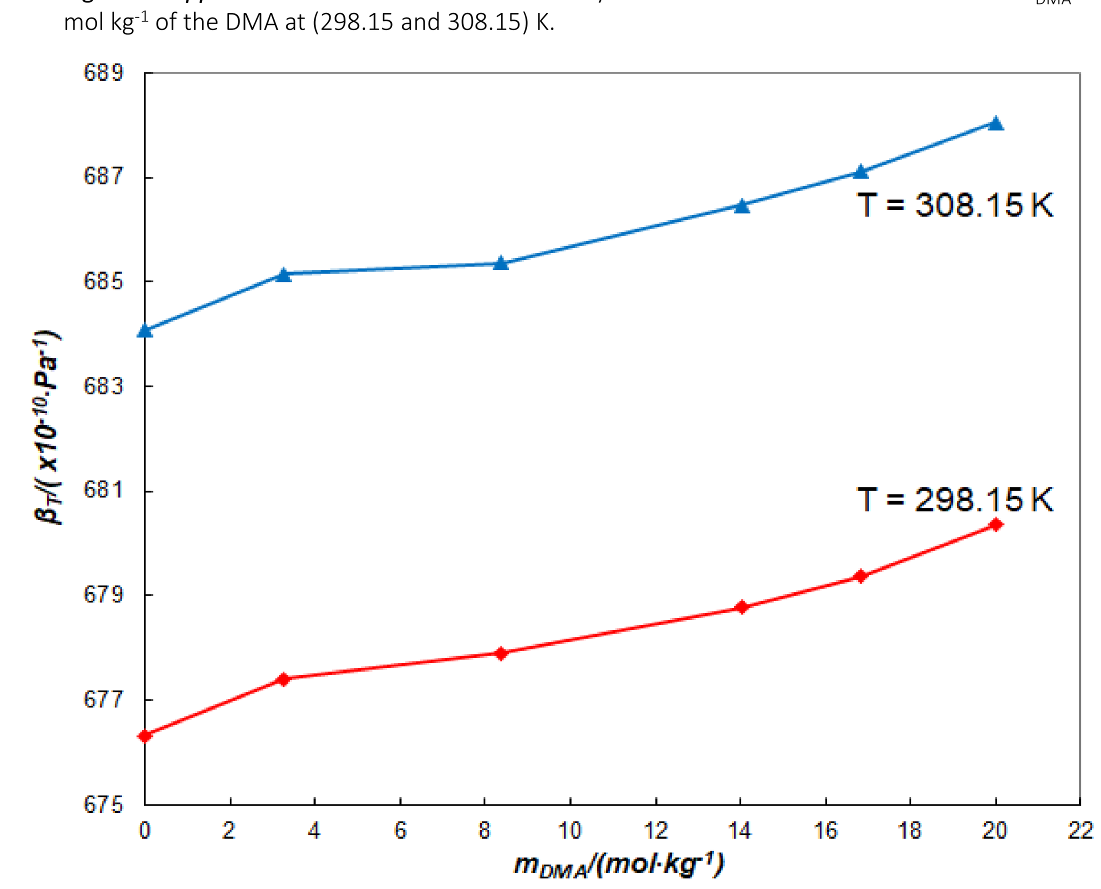

Fig.4. The **isentropic compressibility** values in ternary DMA-PEG20000-DMF mixture versus m_{DMA} mol kg^{-1} of the DMA at (298.15 and 308.15) K.

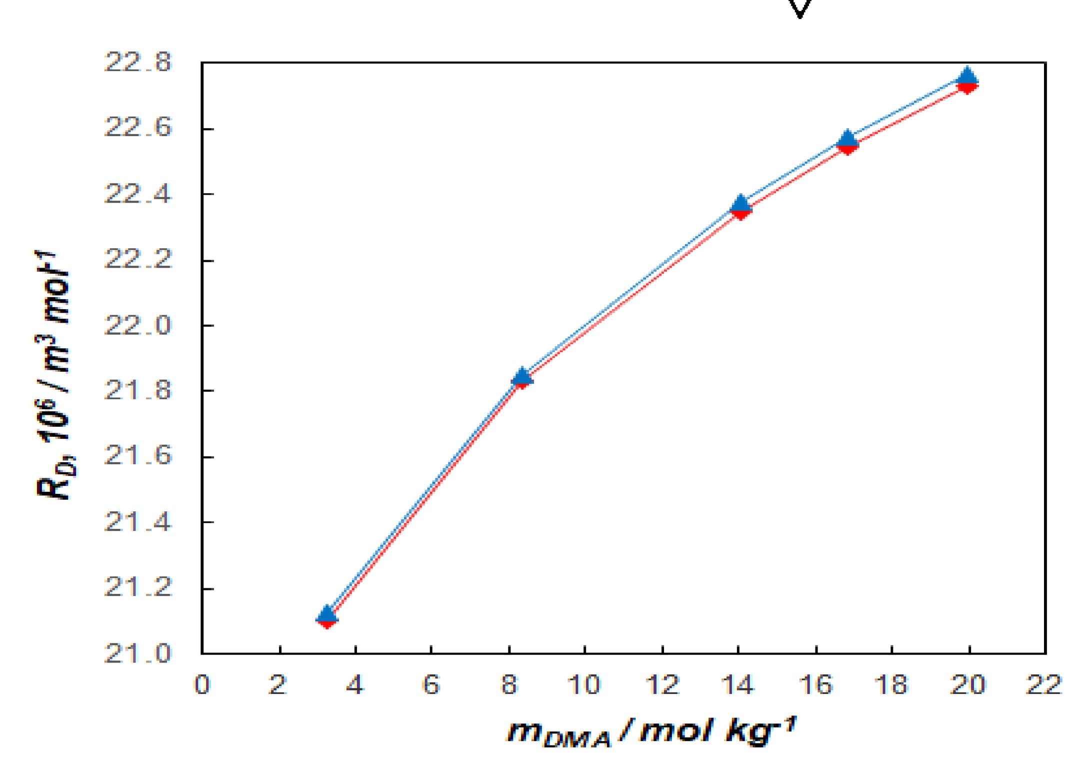

Fig.6. The *molar refraction* values in ternary DMA-PEG20000-DMF mixture versus m_{DMA} mol kg^{-1} of the DMA at (298.15 and 308.15) K.

CONCLUSIONS

- Density, speed of sound, and refractive index in binary mixtures were measured at molalities of m_{DMA} = (0, 3.2737, 8.3724, 14.0314, 16.8263, and 19.9881) mol/kg for DMA and of m_{PEG} = (0 and 0.001002) mol/kg for PEG + DMF, respectively, and at temperatures of (298.15 and 308.15) K.
- The results indicated that the obtained derived properties depend on the temperature and on the composition of the mixture, which is indicative of the presence of molecular interactions between solute and solvent. As the temperature increases, the molecules between solute and solvents are loosely bound and the kinetic energy of molecules increases. Knowledge of the thermodynamics behavior of the dimethylacetamide in (polyethylene glycol 20000 + dimethylformamide) binary solvent is very important for biological, pharmaceutical and industrial processes.

ACKNOWLEDGEMENTS The authors gratefully acknowledge the financial support of the EU (ERDF) and Romanian Government that allowed the acquisition of the research infrastructure within POS-CCE O 2.2.1 project INFRANANOCHEM, no. 19/01.03.2009, and the Research Programme Chemical Thermodynamics of "Ilie Murgulescu" Institute of Physical Chemistry.