Thermochimica Acta, 143 (1989) 205–209
Elsevier Science Publishers B.V., Amsterdam – Printed in The Netherlands

CRYOSCOPY, VISCOSITY, AND ELECTRICAL CONDUCTIVITY MEASUREMENTS OF THE STRONTIUM NITRATE–ACETAMIDE MOLTEN SYSTEM

G. VITALI and G. BERCHIESI

Dipartimento di Scienze Chimiche Università degli Studi di Camerino, Via S. Agostino n.l, 62032 Camerino (Italy)

S. BAROCCI

E.P.O. Patenlaan 2, 2280 HV Rijswijk (ZH) (The Netherlands)

(Received 3 August 1988)

ABSTRACT

Liquid–solid equilibrium temperatures of the strontium nitrate–acetamide molten binary system were measured in the range of concentrations allowed by the thermal stability of the amide. The measurements show a mole-fraction range where a limited supercooling phenomenon appears. The measurements of viscosity and electrical conductivity were performed for the mole fraction $X_1 = 0.8745$ mixture, up to the temperature allowed by the supercooling phenomenon.

INTRODUCTION

In recent years attention has been drawn to the binary mixtures of some molten amides, particularly acetamide, and electrolytes [1–11]. Such mixtures show supercooling phenomena which are probably induced by the presence of cations of alkali and alkaline earth metals. The results of our research up to now suggest that Na^+, of the various cations, is primarily responsible for the supercooling phenomena; in fact in some cases binary mixtures containing Na^+ reach the glass transition temperature.

These supercooled liquids exhibit viscoelastic behaviour [12–14] and high ultrasonic losses in the megahertz region [15], as well as dielectric relaxation [16] which may be explained on the basis of a polymeric structure built via aggregation phenomena of solvated ions. In this note we present the results of cryoscopic, viscosimetric, and electrical conductometric measurements for the binary system acetamide–$Sr(NO_3)_2$.

0040-6031/89/$03.50

EXPERIMENTAL

The experimental methods used for the cryoscopy, viscosity, and electrical conductance measurements have been described previously [17–19]. For the measurement of melting points near room temperature, the equipment described in the paper by Braghetti et al. [18] was employed, and refrigerated using circulation of thermostatted liquid from a F 40 Julabo cryostat. The chemicals employed were: acetamide EGA-CHEMIE 96%, purified by sublimation and dried under dynamic vacuum at room temperature; $Sr(NO_3)_2$ ERBA RPE dried under dynamic vacuum at 180 °C.

RESULTS AND DISCUSSION

The liquid–solid equilibrium temperatures, as a function of the mole fraction of acetamide are given in Table 1. The plot of T/X_1 (where the subscript indicates acetamide) of the liquid–solid boundary curve is presented in Fig. 1. In Fig. 2 the plot of $\Delta T/K\nu m$ versus m is shown, where ΔT is the cryoscopic lowering, m the molality, ν the sum of the number of cations and anions in the salt formula, and K the thermodynamic cryoscopic constant of acetamide [1].

It was not possible to investigate the entire range of concentrations owing to the thermal stability of the amide, so therefore measurements were performed up to the mole fraction $X_1 = 0.8699$. At this mole fraction the

TABLE 1

Liquid–solid equilibrium temperatures in the binary system CH_3CONH_2–$Sr(NO_3)_2$

X_1	T (K)
1.0000	353.3
0.9977	352.4
0.9905	351.0
0.9878	350.8
0.9847	350.7
0.9805	349.7
0.9755	349.0
0.9654	347.3
0.9554	345.7
0.9349	341.9
0.9184	336.1
0.8998	331.1
0.8893	327.7
0.8887	326.6
0.8799	321.4
0.8699	319.2

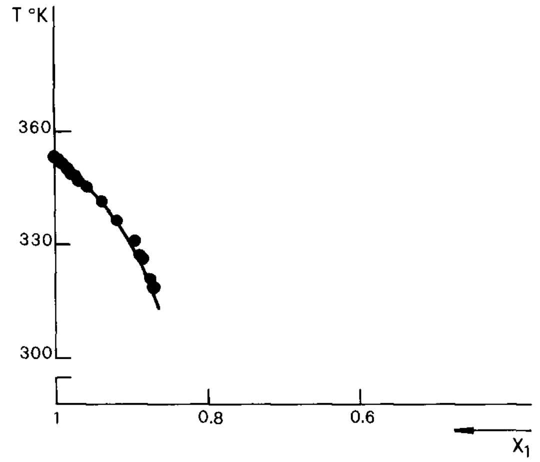

Fig. 1. Liquid–solid equilibrium curve for the binary system CH_3CONH_2–$Sr(NO_3)_2$.

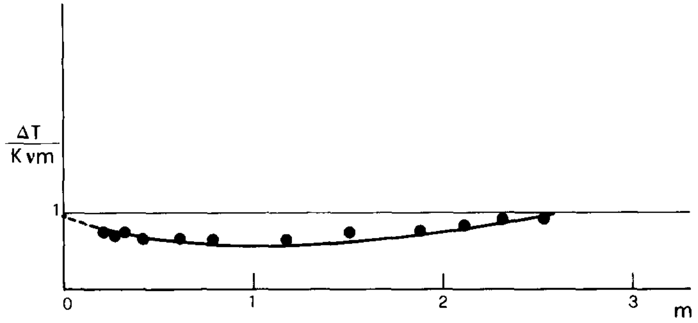

Fig. 2. A plot of $\Delta T/K\nu m$ versus m for the binary system CH_3CONH_2–$Sr(NO_3)_2$.

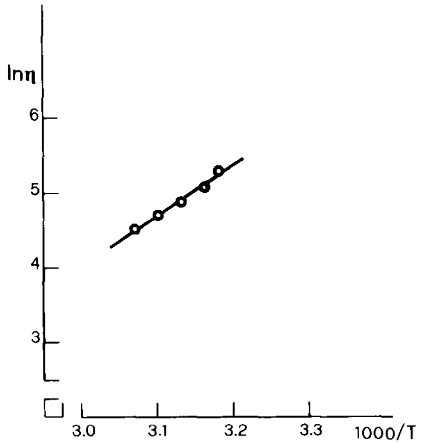

Fig. 3. A plot of ln η versus $1/T$ for the mole fraction $X_1 = 0.8745$ (η in cP).

TABLE 2

Viscosity values (η) as a function of T for the mole fraction $X_1 = 0.8745$

T (K)	η (cP)
314.2	194.0
316.7	162.2
319.7	132.0
322.7	110.8
325.7	92.6

TABLE 3

Specific electrical conductivity (χ) as a function of T for the mole fraction $X_1 = 0.8745$

T (K)	χ ($\times 10^4\ \Omega^{-1}\ \mathrm{cm}^{-1}$)
314.3	8.7
316.8	10.1
319.3	11.5
321.2	12.8
323.8	14.6

binary mixture shows limited supercooling when the mixture is stirred, which is enhanced without stirring, whereas the other mixtures do not show important supercooling phenomena. The value of $\Delta T/K\nu m$ for the most dilute solutions were used to calculate the degree of dissociation: ca 0.51.

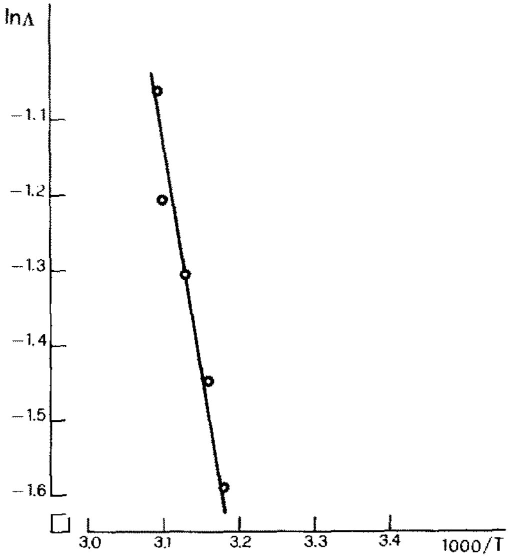

Fig. 4. A plot of ln Λ versus $1/T$ for the mole fraction $X_1 = 0.8745$, (Λ in Ω^{-1} cm^2 eq^{-1}).

Furthermore, the plot of $\Delta T/K\nu m$ versus m suggests that the degree of dissociation increases with increasing m (that is decreasing T), even if Raoult's law is not strictly valid for increasing m. The physical meaning of this trend has been discussed previously [3]. The experimental results of viscosity and specific electrical conductance are given in Tables 2 and 3, respectively. Figures 3 and 4 show Arrhenius plots, for the dependence of viscosity (η) on T and the equivalent conductivity (Λ) on T, respectively.

As in preceding measurements [17], the slope of the Arrhenius plots must be regarded as a temperature coefficient rather than as a real activation energy (E_{act}) owing to the numerous equilibria involved in this solution.

ACKNOWLEDGMENTS

We are grateful to the Ministero della Pubblica Istruzione for financial support and to R. Borgarucci for his technical assistance.

REFERENCES

1 F. Castellani, G. Berchiesi, F. Pucciarelli and V. Bartocci, J. Chem. Eng. Data, 26 (1981) 150.
2 F. Castellani, G. Berchiesi, F. Pucciarelli and V. Bartocci, J. Chem. Eng. Data, 27 (1982) 45.
3 G. Berchiesi, G.G. Lobbia, V. Bartocci and G. Vitali, Thermochim. Acta, 70 (1983) 317.
4 G.G. Lobbia and G. Berchiesi, Thermochim. Acta, 72 (1984) 391.
5 G.G. Lobbia, G. Berchiesi and G. Poeti, Thermochim. Acta, 74 (1984) 247.
6 G.G. Lobbia and G. Berchiesi, Thermochim. Acta, 74 (1984) 251.
7 G.G. Lobbia, G. Berchiesi and G. Poeti, Thermochim. Acta, 78 (1984) 297.
8 G.G. Lobbia and A. Amico., Thermochim. Acta, 87 (1985) 257.
9 G.G. Lobbia and G. Berchiesi, J. Chem. Eng. Data, 109 (1987) 52.
10 G.G. Lobbia and G. Berchiesi, Thermochim. Acta, 118 (1987) 223.
11 G. Vitali and G. Berchiesi, Thermochim. Acta, 142 (1989) 13.
12 G. Berchiesi, G. Vitali, P. Passamonti, and R. Płowiec, J. Chem. Soc., Faraday Trans. 2, 79 (1983) 1257.
13 R. Płowiec, A. Amico and G. Berchiesi, J. Chem. Soc., Faraday Trans. 2, 81 (1985) 217.
14 G. Berchiesi, G. Vitali and A. Amico, J. Mol. Liquids, 32 (1986) 99.
15 G. Berchiesi, F. Castellani and F. Pucciarelli, J. Pure Appl. Ultrason., 5 (1983) 66.
16 A. Amico, G. Berchiesi, A. Di Biasio and C. Cametti, J. Chem. Soc., Faraday Trans. 2, 83 (1987) 277.
17 G. Berchiesi, G. Vitali and A. Amico, J. Chem. Eng. Data, 30 (1985) 208.
18 M. Braghetti, D. Leonesi and P. Franzosini, Ric. Sci., 38 (1968) 116.
19 M. Braghetti, G. Berchiesi and P. Franzosini, Ric. Sci., 39 (1969) 576.