Conductivities of Room Temperature Molten Salts Containing $ZnCl_2$, Measured by a Computerized Direct Current Method

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Abstract

The conductivities of the binary room-temperature molten salt systems $ZnCl_2$-N-n-butylpridinnnium chloride (BPC), $ZnCl_2$-1-ethyl-3methylimidazolium chloride (EMIC) and $ZnCl_2$-benzyltriethylammonium chloride (BTEAC) have been measured at different temperatures and compositions by a d.c. four-probes method. The conductivities of the three RTMS are in the order $ZnCl_2$-EMIC > $ZnCl_2$-BPC > $ZnCl_2$-BTEAC.

In the $ZnCl_2$-BPC system the conductivity at 70 to 150 ℃, has maxima at 40 mol% $ZnCl_2$. In the $ZnCl_2$-EMIC system, the conductivity is slightly different at 30 mol% to 50 mol% $ZnCl_2$, while it considerably increase from 70 to 150℃, and it has the lowest activation energy 25.21 kJ/mol. For these two systems, the conductivities decrease rapidly beyond 50 mol% $ZnCl_2$, owing to the rapid increase in cross-linking and resultant tightening of the polyelectrolyte structure. As to the $ZnCl_2$-BTEAC system, the conductivities at 110-170℃ gradually decrease slowly at 30-60 mol% $ZnCl_2$. The conductivities of $ZnCl_2$-EMIC melt are compared with those of the $AlCl_3$-EMIC melt previously studied.

The stability of the $ZnCl_2$-EMIC melt system is explored by the effect of external environment on the conductivity and the FTIR spectrum. It reveals that the effect is slight, and that the $ZnCl_2$-EMIC melt may be classified as a stable melt.

Key words: Conductivity, Room-temperature molten salt, $ZnCl_2$, Direct current method, Stable melt.

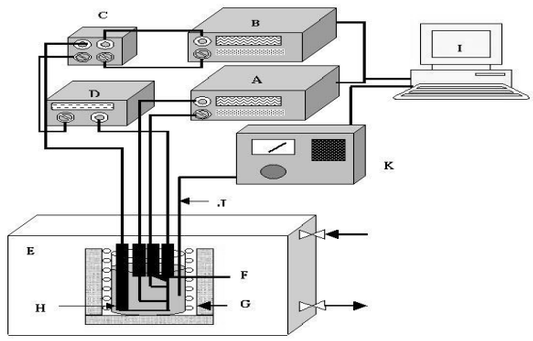

Fig. 1. The apparatus for the computerized measurement system of conductivity .

A. Mutlimeter1	G. Furnace
B. Multimeter2	H. Silicon oil
C. 10Ω standard resistor	I. IBM-PC
D. DC power supply	J. Thermal couple
E. Glove box	K. Temperature controller
F. Conductivity cell	

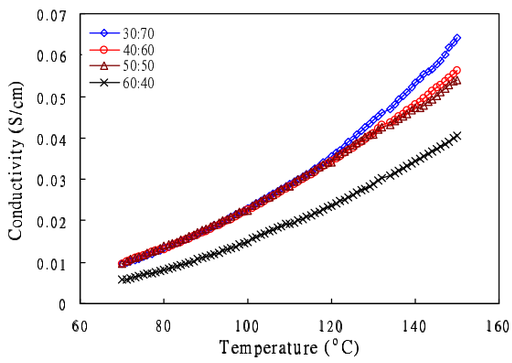

Fig. 2. The electrical conductivity of molten mixtures of $ZnCl_2$:EMIC as a function of temperature. Composition in mol%: ◇, 30:70; ○, 40:60; △, 50:50; ×, 60:40.

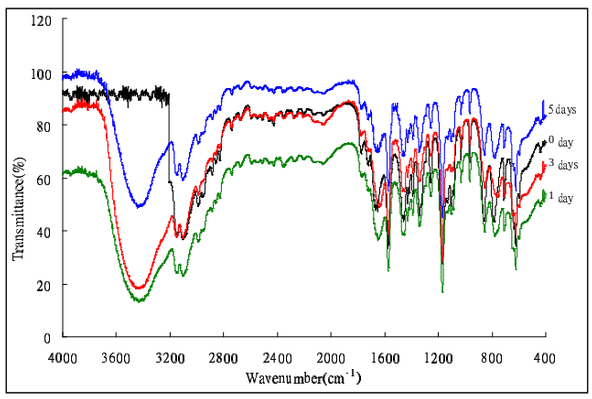

Fig. 3. The FTIR spectrum of 40 mol% $ZnCl_2$:60 mol% EMIC melt at various storage days.

Table 4. Activation energies (Ea) from Arrhenius fits of the conductivity data

Melt composition	Ea σ (kJ/mol) 30:70	40:60	50:50	60:40
$ZnCl_3$ – BPC	38.32	32.96	35.90	46.47
$ZnCl_3$ – EMIC	28.09	25.99	25.21	29.13
$ZnCl_3$ - BTEAC	46.78	49.97	55.29	49.91