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CHARACTERISATION OF AgI-TlI SOLID ELECTROLYTE SYSTEM

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Solid electrolyte systems are being extensively used as power sources in microelectronic circuits and devices. The performance of the cell,

Ag [AgI + TlI] I_2 (C)
80% 20%

has already been reported. This was done on the basis that most of the AgI-MI based compounds are formed in the ratio 4:1.

DTA and XRD data are presented for this system in a wide range of compositions to study the various phases formed and their transitions in order to understand the nature of compounds formed from the point of view of using them as the solid electrolyte materials for room temperature battery applications.

Key words: AgI - TlI mixed solid electrolyte, compositions, impedance, DTA and cell study

INTRODUCTION

Solid electrolyte systems are being extensively used as power sources in microelectronic circuits and devices. Though $RbAg_4I_5$ was found to be the best among substituted-AgI based compounds, it is not stable both in iodine and moisture. More efforts are being taken to achieve cells with improved performance, particularly at room temperature. In an earlier communication [1] preliminary studies with the system 80%AgI-20%TlI were presented using I_2+C (graphite) as cathode. This showed a capacity of 2 mAh from a discharge at 20μA.

In this paper, a complete study of the above system is presented for a wide range of compositions. The performance of cells with different compositions as electrolytes using a different variety of carbon in the cathode is compared.

EXPERIMENTAL

Samples with different compositions of AgI and TlI were prepared as described earlier [1]. In the present study, the samples were heated at 623K for 24 hours.

The DTA peaks were obtained using a set-up described earlier [2]. The XRD data were obtained using Cu.K_α radiation (λ = 1.548 A).

The impedance studies were carried out in the frequency range 5 Hz to 100 KHz using PAR-AC Impedance System (Model 368-1) employing pellets with gold coatings on both sides.

RESULTS AND DISCUSSION

It is found that as TlI content increases, the sample becomes very brittle and can be powdered easily.

The temperatures corresponding to the different DTA peaks are given in Table [1]. From this data, the phase diagram showing the various transitions is obtained and shown in Fig.1. Earlier reports [3-6] show the formation of two compounds having the formulae, $TlAgI_2$ and Tl_2AgI_3 exhibiting very poor conductivity.

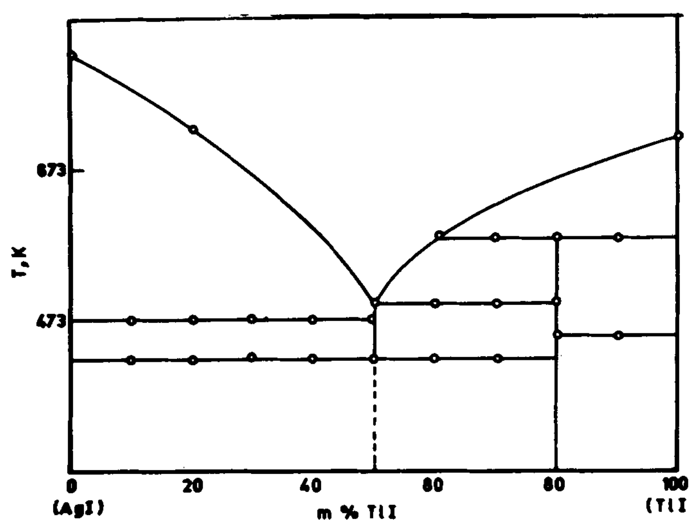

Fig.1: Phase diagram of AgI - TlI system

In the present study, there is no clear indication for such compounds. Even XRD shows mixed patterns as seen from the 'd' values (Table II). Very strong lines are found overlapping. Both DTA and XRD do not give any indication for the formation of clear compounds.

However, the impedance data at 100 KHz shows some interesting results. From Table III we can note that the conductivity (at room

TABLE-I: Temperatures corresponding to different DTA peaks

m/o TlI	Temperatures of DTA peaks showing transitions K					
10	415	--	470	--	--	--
20	416	--	473	--	--	--
30	420	--	475	--	--	--
40	418	--	473	--	507	--
50	418	--	472	499	--	--
60	415	--	--	496	--	--
70	416	--	--	496	--	581
80	--	451	--	495	--	581
90	--	447	--	--	--	581

TABLE-II: 'd' values using Cu-K_{α} line (strong lines)

AgI	m% TlI									
	10	20	30	40	50	60	70	80	90	TlI
3.909	3.67	3.68	3.69	3.28	3.3	3.3	4.04	3.27	3.28	3.278
3.685	2.78	3.30	3.31	2.90	2.91	3.18	3.28	3.18	3.20	3.176
3.460	2.27	2.91	2.91	2.78	2.78	2.96	3.19	2.97	2.99	2.656
2.270	1.94	2.8	2.79		2.61	2.90	2.97	2.78	2.78	2.590
2.099		2.27	2.61		1.94	2.78	2.78		2.66	2.268
			2.28			1.96				2.021
			1.95							1.854
										1.618
										1.514

temperature) falls with increasing TlI content upto 60 m% TlI and again increases with further increase in TlI content. The complex impedance diagrams are given in Figs.2(a) to 2(f).

Cell performance

With an aim to support the conductivity behaviour, the performance of these compositions in actual cell assembly was carried out. Cells of the following configuration were assembled by pressing together the various layers at 15 tons pressure.

Ag [Electrolyte] I_2(C)

In the above cells, dried and powdered aquadag was used with iodine in the cathode in the ratio I_2:C = 1:2.5. Aquadag possesses good adhesion compared to graphite powder and gives same range of SCC (short circuit current). From Table IV, it can be found that the impedance behaviour is not at all reflected. A composition containing 80% AgI-20% TlI shows highest SCC confirming our previous observations. There is a continuous fall in the SCC as TlI content increases. Practically no current is observed beyond 60% TlI, even though the conductivity of a sample containing 20% AgI-80% TlI is comparable to that of 80% AgI-20% TlI. However, the discharge with cathode containing aquadag is faster.

TABLE - III: Conductivities from impedance data (at 100 KHz)

m% TlI	x10^6 $ohm^{-1}cm^{-1}$
20	6.79
30	6.49
50	4.97
60	4.6
70	5.67
80	6.67

TABLE-IV Cell performance :

m% TlI	SCC (μA)
20	470
30	330
50	75
60	35
70	0
80	0

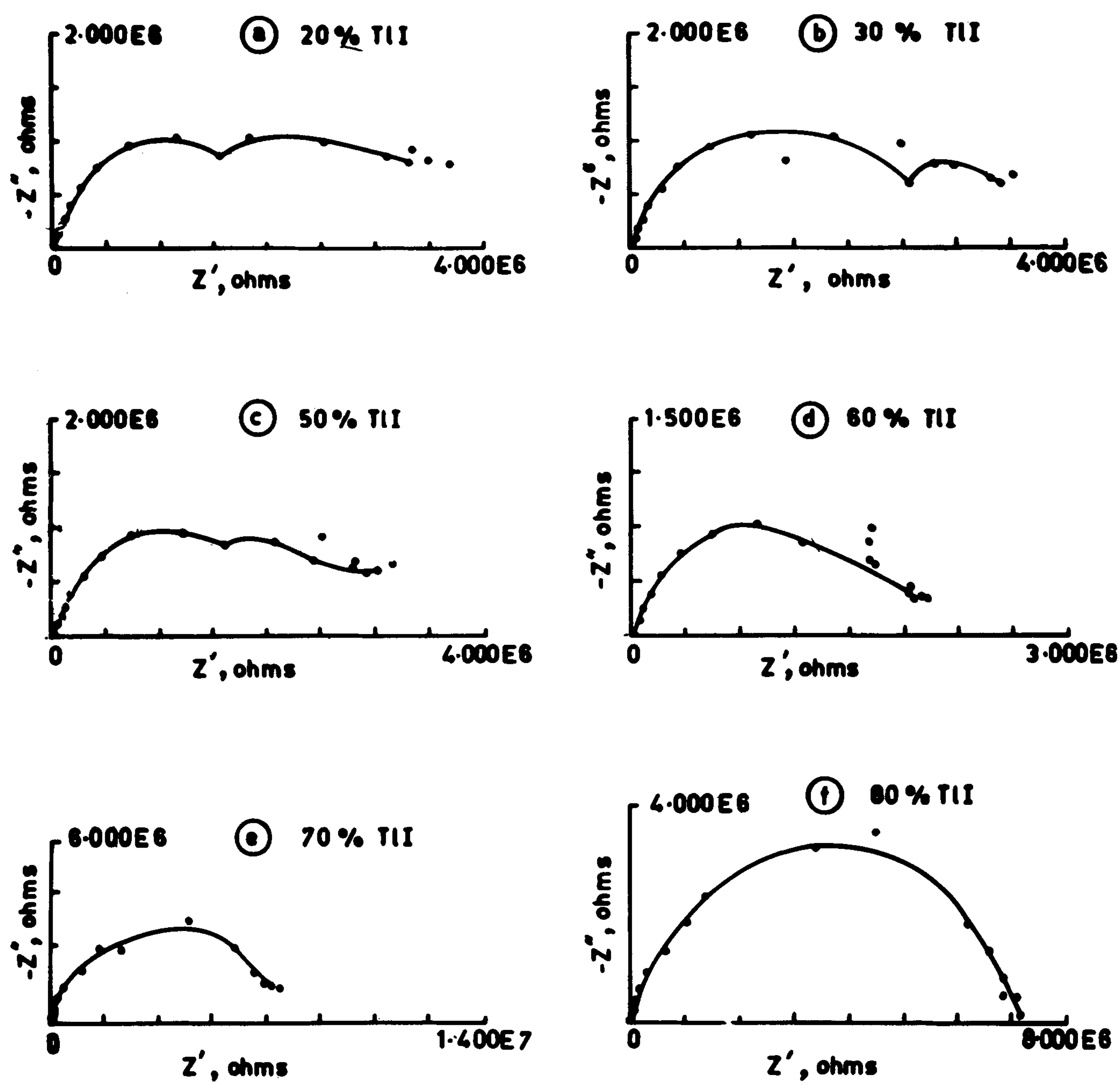

Fig.2: Complex impedance diagram of AgI - TlI system

With 80% AgI-20% TlI, a cathode containing a disk of conducting proprietory graphite felt soaked in iodine solution and dried, gave more than 600 μA (an increase of 30-50%) compared to other carbons. But this was not strong and adhesive.

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REFERENCES

1. J Kuppusami, V Sundaram and A Sundara Raj, *AgI-TlI Solid Electrolyte Battery,* Proc. of Fifth Natl. Conf. on Power Sources, Batteries and Fuel Cells, SAEST, held at Bangalore, 1986
2. J Kuppusami, V Sundaram and A Sundara Raj, *B. Electrochem,* **2** (1986) 197
3. F P Platonov, *Trudy Moskov Selsko-Khoz, Akad, Im. K.A.Timiyazeva,* **36** (1946) 13
4. L G Berg and I N Leposhkov, *Izvest. Sekt. fiz-khim. Anal., Inst. Obshchel Inorg. Khim,* **15** (1957) 144
5. H Hirsch., *J Chem Soc,* (1963) 1318
6. J N Bradley and P D Greene, *Trans Faraday Soc,* **63** (1967) 424