

# Impedance studies of Nasicon solid electrolyte

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Nasicon powder was synthesized by calcining a mixture of  $\text{Na}_2\text{ZrO}_3$ ,  $\text{SiO}_2$  and  $\text{NH}_4\text{H}_2\text{PO}_4$  initially at 445K for 16 hours and later at 1273K for 4 hours. The calcined powder was vibromilled and pressed into pellets after adding suitable binder. The pellets embedded in coarse powder of the same composition was sintered at 1473K for 2-3 hours. The apparent density of the pellet was measured. Ionic conductivity was measured by the a.c. impedance technique. Results are presented in this paper.

**Key words:** Impedance, Nasicon solid electrolyte

## INTRODUCTION

Nasicon is a sodium ion conducting solid electrolyte. The fast sodium ion transport in this material is related to the existence of three dimensionally linked vacancies in a rigid structure of  $\text{SiO}_4$  and  $\text{PO}_4$  tetrahedra sharing corners with  $\text{ZrO}_6$  octahedra [1]. In this paper, the conductivity of Nasicon obtained by impedance method has been presented.

## EXPERIMENTAL

Nasicon powder was synthesized by calcining a mixture of  $\text{Na}_2\text{ZrO}_3$ ,  $\text{SiO}_2$  and  $\text{NH}_4\text{H}_2\text{PO}_4$  initially at 445K for 16 hours and subsequently at 1273K for 4 hours so as to attain the composition corresponding to  $\text{Na}_3\text{Zr}_2\text{Si}_2\text{PO}_{12}$ . The calcined powder was vibromilled and pressed into pellets of 3 cm dia and 0.3 cm thickness after adding suitable binder. The pellet was embedded in coarse powder of the same composition and sintered at 1473K for 2-3 hours. The apparent density of the pellet was measured in isobutyl alcohol.

Gold blocking electrodes (1 cm dia) were sputtered on each face of the pellet. Electrical contact with the sample was made via gold coated copper discs. Experimental set-up is shown in Fig. 1. Prior to measurement the furnace was flushed with pure dry argon and a slight positive pressure was maintained during measurement. Impedance measurements were conducted over the temperature range of 303 to 673K and in the frequency range from 5 Hz to 100 K.Hz with PAR impedance system coupled with APPLE 2 E computer set-up.

## RESULTS AND DISCUSSION

The apparent density was found to be 3.2 g/c.c. Complex plane and admittance plots were obtained from the output of the computer terminal of the system. From

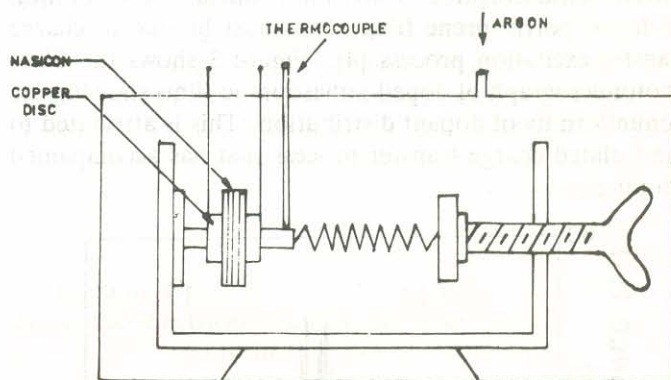


Fig. 1: Experimental set-up

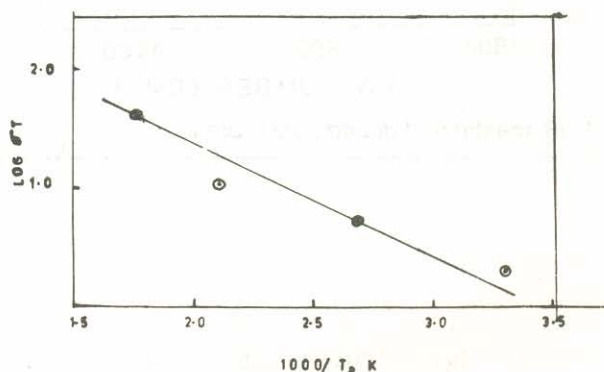


Fig. 2: Arrhenius plot

the impedance values, the total conductivity at each temperature was derived from an extrapolation to zero reactance of the impedance plot [2]. Activation energy was calculated from the graph (Fig. 2). The value was

found to be 0.17 e.V. which agrees with the reported value [3,4]. Nasicon thus prepared exhibits reasonable conductivity values at 573K.

#### REFERENCES

1. H Y P Hong, *Mat Res Bull*, **11** (1976) 173
2. M L Bayard and G G Barna, *J Electroanal Chem*, **91** (1978) 201
3. V A Nicholas, P J Johnson and A I Kingon, *Solid State Ionics*, **17** (1985) 351
4. D Raistrich and R A Huggins, *Proc Symp Workshop Adv Battery*, R & D, Argonne National Laboratory, 76-8, B277, (1976)