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Properties of Rare – Earth at High Temperature

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Abstract : In this paper we study the properties of some rare – earth compounds at high temperature. In this regard we study current density as a function of applied electric field and time. This ensures ohmic contact between pellet and electrode interface, which is essential condition for the study the transport properties of the compounds

Keywords : Current density, Electric field, XRD, Electrical conductivity, Dielectric constant.

1. Introduction :

Determination of electrical conduction mechanism in a material which conducts very little is a very difficult task. First one has to find out whether conduction is electronic or ionic or mixed, then to determine the source of ionic conduction or the electronic conduction. After this has been decided one has to find out the mechanism of conduction and evaluate various parameters like number, activation energy and mobility of charge carriers using appropriate models. To have good quantitative idea of above mentioned parameters one needs several types of experimental data e.g. electrical conductivity as a function of time, electric field, a.c. signal frequency, temperature and doping [1-3]. Dielectric constant and loss as a function of frequency and temperature [4-6]. Seeback coefficient as a function of temperature [7-8]. For such measurements it is essential that the contact between the pellet and electrode interface should be ohmic [9].

2. Material Preparation and Experimental Techniques :

All the studied rare-earth compounds have been prepared by solid state reaction technique and characterized by XRD pattern using CuK_α radiation (λ = 0. 15418 nm) [10]. The starting materials for preparation of $LaTiO_3$, $CeTiO_3$ and $PrTiO_3$ have their common oxide namely La_2O_3, CeO_2 and Pr_6O_{11} (all procured from Flueka AG, Switzerland with stated parity of 99.99%) and TiO_2 (procured from Bonds, India with stated purity of 99.9%). The stoichimetric amounts of respective oxide and TiO_2 were taken to mix thoroughly. After mixing these materials were pressed and fired at 1400K for 50 hours with one intermediate grinding.

The prepared materials, were ground in the agate morter till there are obtained a very fine powders. The powders were pressed in a die with a hand operated hydraulic press to obtain the pellets of required dimensions. The pressed pellets were ejected from die mechanically. The pellets were sintered in air at a temperature 1000K about 48 hours.

The pellets are cylindrical in shape. In order to ensure the thickness of the pellet should be uniform everywhere, a part of the pellet has to be removed. This is done by grinding the uneven part away by a sand paper. The plane surfaces are made smooth using polish papers. For the measurement of electrical conductivity we used silver paint as electrodes. Silver paint was uniformly coated on surface when silver fails are pressed on these silver electrode, an ohmic contact is obtained.

3. Study of Current density as a function of applied electric field and time

Electrodes play an important role in the measurement of electrical conductivity. For such measurement it is essential that the contact between the pellet and electrode interface should be ohmic [11]. Even in the case of the ohmic contact, the contact resistance play on important role in the measurement of electrical conductivity for high conducting solids. However, they are relatively less important in the case of low conducting solids. To ensure the ohmic contact between the pellet and electrode interface, the current through the pellet has been measured at different applied voltage at constant temperature. Both current through and voltage across the pellet have been measured using keithley digital multimeter type 171. Using dimension of the pellet, the current density (J) and Electric field (E) have been evaluated. The results for different compounds are shown in figure 1. It is seen from the fig. it is found J vs E plots are linear. This ensures ohmic contact between pellet and electrode interface.

Current density through different rare – earth compounds have been measured with time at constant temperature. The applied field was in the range corresponding to ohmic contact. The results obtained in figure 2. It is observed from the fig. that the current is independent of time. From there observation we conclude that there is no ionic conductivity in studied compounds.

4. Conclusions :

1. The pressed pellets of these compounds at higher pressure have relatively high density.

2. These are typical semi conductivity materials.

3. These are essentially electronic conductors and have almost no ionic conductivity over the temperature range (400 – 1200K)

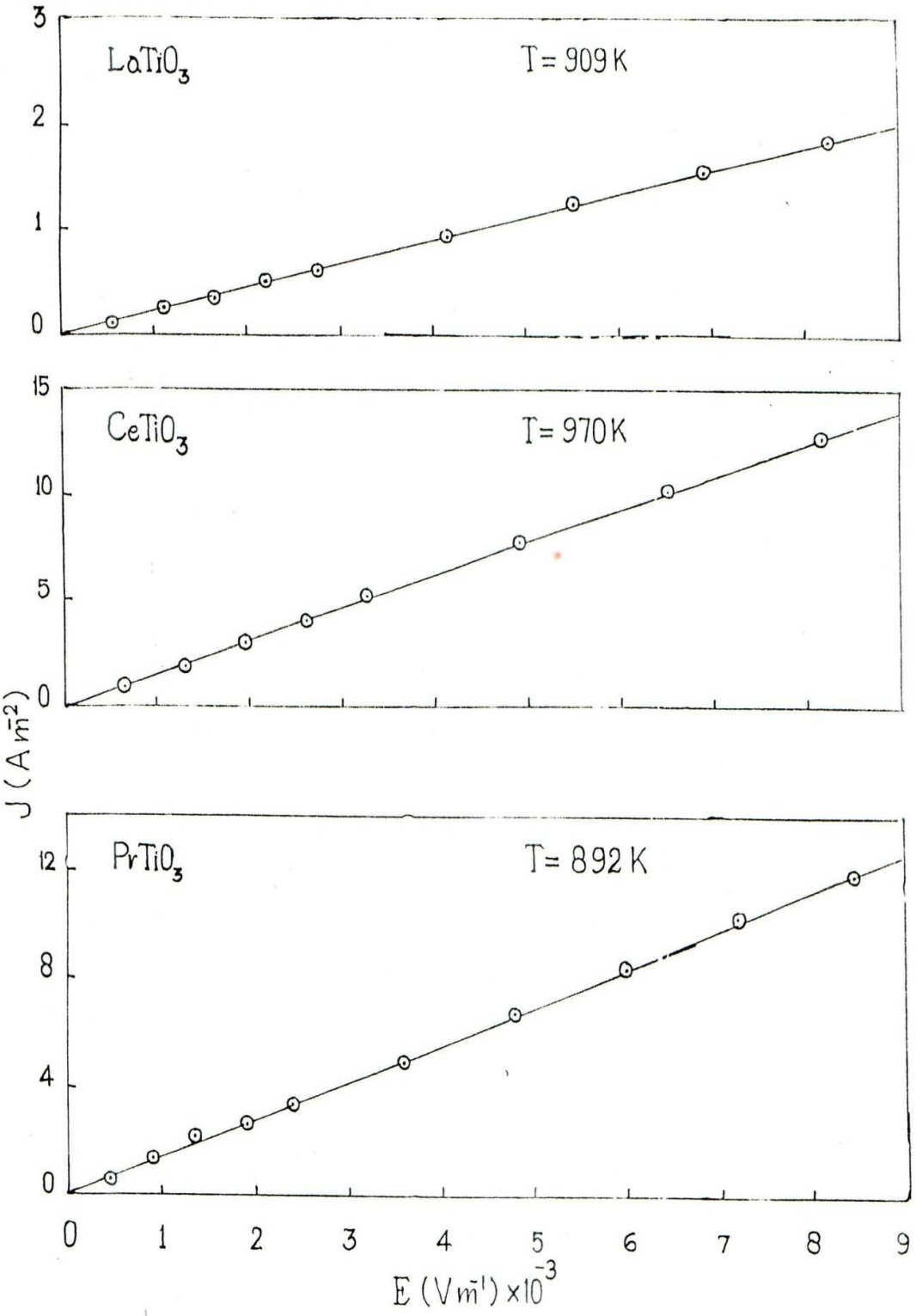

Fig. 1. : Plots of Current Density (J) Against Electric Field (E) At Constant Temperature

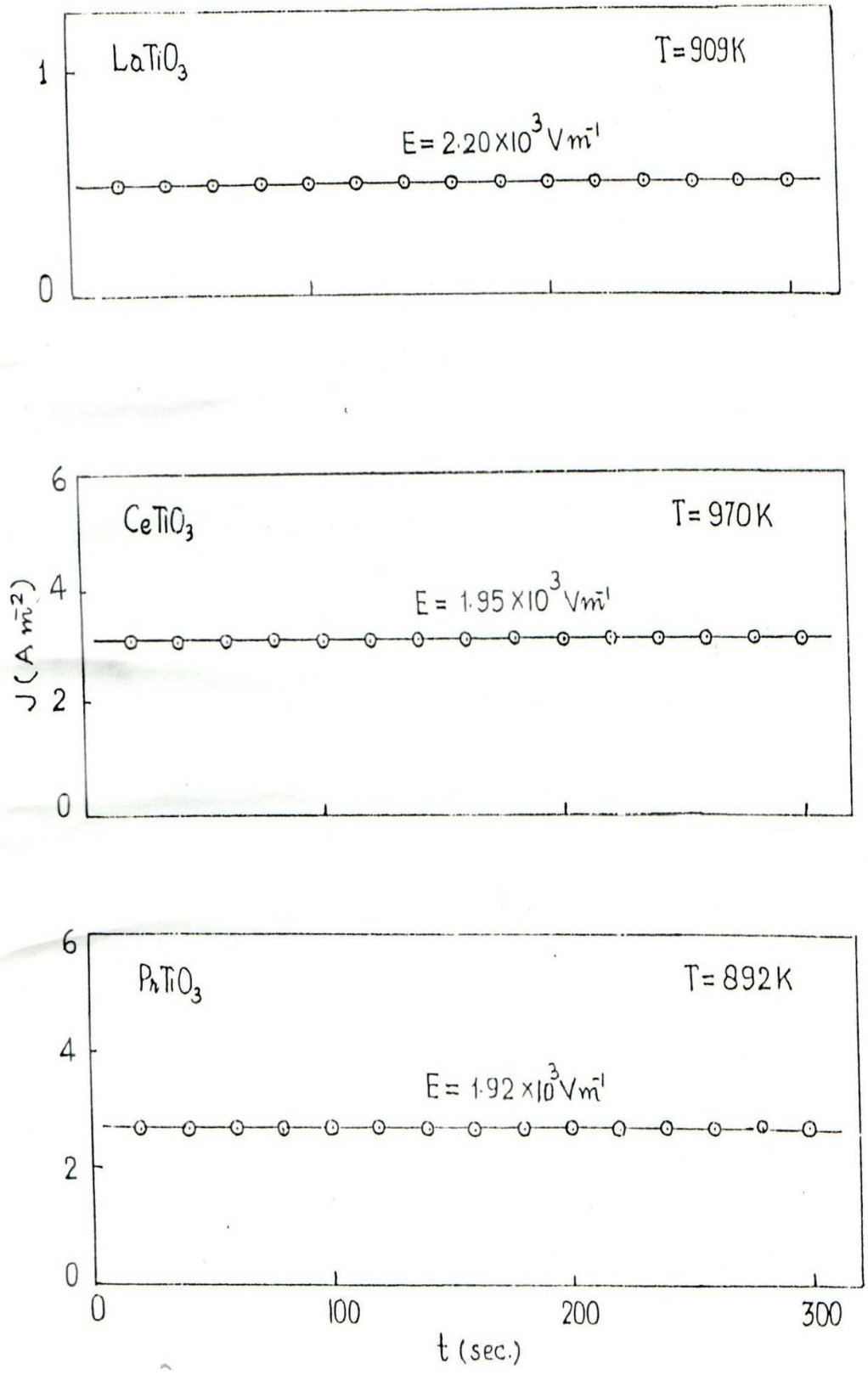

Fig. 2. : Plots of Current Density (J) Against Time (t) At Constant Temperature and Field

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