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Electrical resistivity and pyroelectricity of potassium acetyl-acetonate polycrystals

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Data have been obtained on the behaviour of electrical resistivity at various temperatures and static stresses on purely prepared potassium acetylacetonate polycrystals. The temperature dependence of pyroelectric voltage was also measured in the same temperature range A phase transition was confirmed to occur at 120°–160°C A correlation between the above measurements and the temperature dependence of the ultraviolet absorption spectra measurements of the investigated specimens was evaluated

1 Introduction

Metal acetylacetonates are of increasing interest in industry as they are mostly used as catalyst and additives

Since all pyroelectrics are piezoelectrics, thus, in certain cases, piezoelectricity is considered as secondary pyroelectricity Primary pyroelectricity in ferroelectric ceramics can arise from two factors, the primary effect of aligned domains and switching of domains by 180° Secondary pyroelectricity can result from 90° domain switching and the secondary effect in aligned domain (Pearls 1958, Cook 1963)

The d.c resistivity of similar compound of sodium-acetylacetonate was previously measured by Sawaby (1973)

Adeev & Zakarov (1966) interpretted the absorption bands in the ultraviolet region for copper acetylacetonate Farona *et al* (1968) studied the effect of lowered symmetry upon various spectra of copper acetylacetonate

The purpose of the present investigation is to attain a high pyroelectric voltage (electrical power) from potassiumacetylacetonate at relatively lower temperature to be used as a tool for the conversion of heat energy or mechanical energy to electrical energy and *vice versa* Other parameters were also included to throw a light on the physicochemical characteristics of potassium acetylacetonate in continuation with that previously given by Tawfik (1974) for sodium acetylacetonate polycrystals

2. Experimental Procedure

Potassium acetylacetonate was prepared by a method as devised by Lewis & Sutherland (1948). This involved the direct action of 50 gm (0.5 mole) of (A.R.) acetylacetone on 11·5 gm (0·5 mole) of A.R. potassium metal in 100 ml of toluene at 100°C. The product was recrystallized from ethanol. The preparation was checked by chemical analysis, X-ray investigation and melting-point determination (261°C, Lewis, Sutherland 1948).

The obtained polycrystals was pressed into pellets at 1000 kg/cm^2, having diameter 12 mm and thickness 3 mm. Two silver electrodes were applied on each pellet for the subsequent electrical resistivity and (E.M.F.) measurements.

The temperature dependence of log electrical resistivity (log ρ/T) was excercised at a range of 25°C up to 207°C. The static stress dependence of electrical resistivity was measured at a range of 0–4 k gm and at various voltages of 50 up to 300 volts. In both cases, the D.C. technique was applied.

The ultraviolet absorption spectra measurements were conducted in the range of 230–400 mμ (nm) and at various temperatures of 20°C, 100°C and 150°C, using the solid technique. A unicam SP 8000 ultraviolet recording spectrophotometer (PYE Unicam LTD Cambridge England) was employed.

2. Results and Discussions

Figure 1 indicates the static stress dependence of electrical resistivity at various applied voltage for polycrystalline potassium acetylacetonate. On

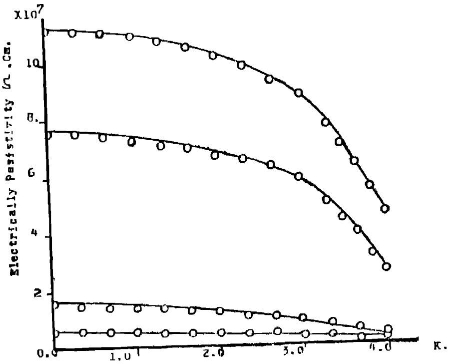

Fig. 1

increasing the applied voltage, up to 300 volts, the resistivity is considerably decreased. This is probably due to the more creation of accumulated charge carriers as a result of the effect of the increased voltage a cross the specimen.

At relatively higher applied voltage up to 300 V, the obtained resistivity static stress curve showed independent character and hence a saturation state is reached indicating the stability zone for the subsequent application and measurements on the test specimens At relatively higher stress (above 3 kg) a successive sudden drops in resistivity take place at the different applied voltage c A notation which is probably due to the generation of electric charge by stress (piezoelectricity) This was explained on the basis that, the applied stress may cause displacement of charges constituting dipoles and this resulted in a greater mobility and flow of charge carriers through the specimen.

Figure 2 indicates the temperature dependence of log ρ (resistivity) of *po* K-acetylacetonate in the range of 25–200°C The curve possesses a negative temperature coefficient of resistivity and hence the material have semiconducting

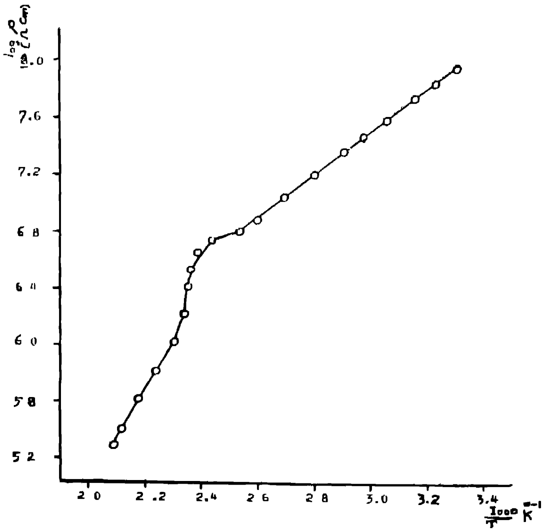

Fig. 1

property. The room temperature value of electrical resistivity of Na-acetylacetonate was previously found by Sawaby (1973) to be 10^{9} (Ω cm) whereas, the present obtained value for k-acetylacetonate was found to be 10^{8} (Ω cm). This noticeable decrease of resistivity on going from Na-acetylacetone to k-acetylacetone is ascribed to the greater metallic character in the same direction At a temperature range of 120–160°C a break down in the straight line (log ρ/T) curve takes place This is correlated to a phase transition which is evaluated from measurements of the pyroelectric voltage (E M F) at the same temperature range (figure 3) From this figure it is evident that the material possesses a high spontaneous pyroelectric voltage (after poling) The situation of the transi-

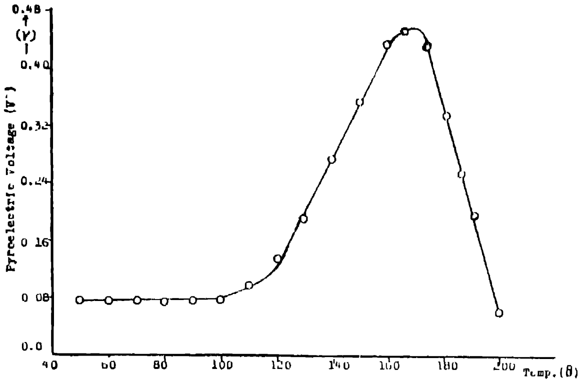

Fig. 2

tion temperature at relatively narrow zone in the resistivity temperature curve (120–160°C than in the E M F/temperature curve (120–190°C) is correlated to the effect of the applied voltage on measuring the resistivity-data

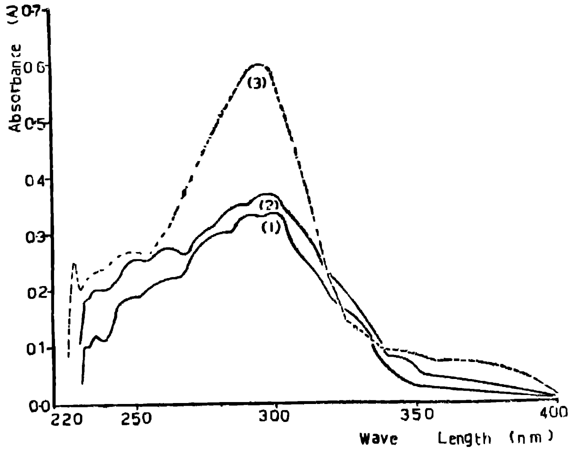

Fig. 3

The ultraviolet absorption spectra measurements (figure 4) of the investigated specimens is taken at various temperatures of 20 up to 150°C.

The obtained absorption bands at 250 nm and 390 nm correspond to ligand metal charge transferes (Ardeev 1966) The band at 300 nm was assigned to the interligand transitions of π–π type. In general, it can be seen that, there is a noticeable shift in the position and intensity of the absorption bands at 150°C (curve 3)

Thus in confirmity with results of the above measurements, there is a situation of phase change above 100°C for potassium acetylacetonate polycrystals.

As it is evident that the material possesses a high spontaneous pyroelectric voltage at relatively low temperatures in junction with its accompanied piezo-electric character, it can be used as a tool for converting thermal (heat) energy or mechanical (stress) energy to electrical energy and *vice versa*.

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