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Electrical conductivity of yttrium samarium dysprosium gadolinium oxalate crystals

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INTRODUCTION

Crystals are pillars of modern technology. Without crystals there would be no electronics industry, no photonic industry, no optic fiber communications, very little modern optical equipment and some very important gaps in conventional engineering.Yttrium Samarium Dysprosium Gadolinium Oxalate (YSmDyGdOx) crystals were grown by gel method. Silica gel method is capable of yielding crystals of high optical perfection and wide morphology. The growing crystals are held in the gel medium in a strain free manner and at the same time nucleation and super saturation are well controlled**.**

Rare Earth compounds are known for their interesting electric, magnetic and luminescent properties. Recent investigations on the fluorescence of some rare earth oxalates[2,3] suggest their potentiality for their optical applications. Rare Earth oxalates evoked greater attention because of their ionic conduction[1]. Electrical conductivity of (YSmDyGdOx) crystals increased with frequency and temperature. Detailed studies of electric conductivity at various temperatures show that the crystal has super ionic nature**.** The grown crystals were characterized by micro hardness measurement

MATERIAL AND METHODS

The gel was prepared by mixing Sodium Meta silicate (density=1.03 g/cc) with Oxalic acid to obtain the desired pH value. A mixed solution of Yttrium Chloride, Samarium Chloride, Dysprosium Chloride, Gadolinium Chloride and Nitric acid was used as the outer electrolyte. The outer electrolyte diffused into the gel to form a colloidal precipitate and it was dissolved by Nitric acid which enhanced crystallization,

RESULTS

The dielectric constant (ε_r) loss tangent ($\tan\delta$) and conductivity (σ) of the pellet samples were obtained as function of frequencies (170Hz-2MHz) at room temperature in an Impedance Analyzer Hewlett Packard (Japan) HP4192A..The nature of variation of these parameters shows that 'ε'and $\tan\delta$ decrease with the increase of frequency. This is due to the presence of all different types of polarizations (viz.electric,dipolar,interfacial, etc) in the compound at room temperature and low frequency.

log f (logarithm of frequency) versus electrical conductivity at various constant temperatures (-24°C, -10°C, 0°C, 5°C, 28°C, 35°C) is plotted in Fig 1 which reveals that electrical conductivity increases with increase of frequency and temperature (B= -24°C, C= -10°C, D= 0°C , E= 5°C ,F= 30°C ,G= 35°C).

The a.c electrical conductivity (σ) and activation energy of YSmDyGdOx crystals were calculated using the formula

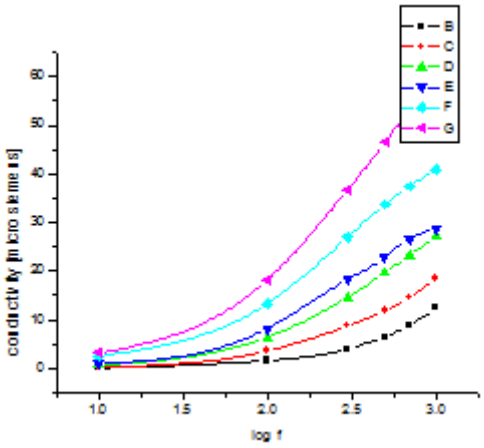

Fig. 1:

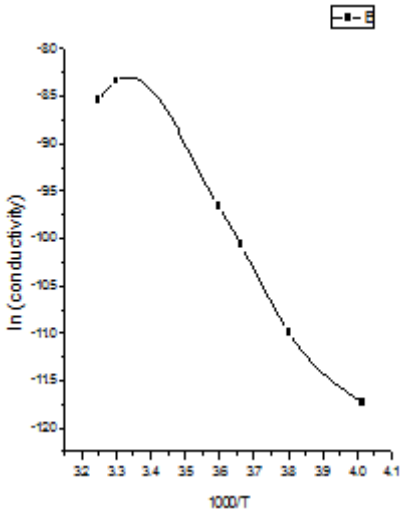

Fig. 2:

$\sigma = \omega \varepsilon \varepsilon_0 \tan\delta$ and $\sigma=\sigma_0 \exp(-E_a/K_BT)$

where ω is the angular frequency, ε_0 the vacuum permittivity, Ea the activation energy and K_B the Boltzmann constant. At 30 kHz, E_a has been calculated from the slope of the ln σ vs 1/T graph as shown in fig2 and was found to be.38828 eV. Such a low value of activation energy is due to high ionic conductivity of YSmDyGdOx supporting its super ionic nature[4].

Conclusion

Precipitation-cum-dissolution control mechanism of the growth of rare earth mixed crystals is no doubt a useful method for growing good quality crystals. Characteristic studies proved crystalline structure, perfectness and composition of the crystal. Electrical conductivity of the crystals finds wide applications in the field of electronic technology.

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