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# Linear and Nonlinear Optical Properties of metal incorporated L-Serine Crystal

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**Abstract -** *L-Serine Potassium Carbonate (LSPC), a metal incorporated amino acid nonlinear optical material is grown by slow evaporation method. The UV transmittance studies show minimum absorption in the entire visible region, cut off wavelength is at 250nm. The optical properties of the grown crystal have been studied by means of transmission measurements in the wavelength region between 200 and 1200 nm. The optical constants such as refractive index (n) and extinction coefficient (k) have been determined from the absorption data. The optical band gap ($E_g$) of LSPC is 6.33eV. Furthermore linear optical parameters such as reflectance, dielectric conductivity and optical conductivity are calculated and its variation with incident photon energy is analyzed. Second harmonic generation (SHG) efficiency of the grown crystal has been studied using Nd:YAG laser.*

***Key Words***: ***SHG*, UV studies, Energy gap, nonlinear optical, dielectric conductivity**

## 1. INTRODUCTION

The search of new materials with large nonlinearity is motivated by the development of nonlinear optical devices such as ultrafast optical switches, power limiters, real time holography, self focusing white-light continuum generation and photonic applications.[1] Ultraviolet (UV) light sources have been strongly demanded from various applications such as photolithography material processing and material treatment. Therefore an UV solid state laser which combines a high power infrared laser with a nonlinear optical crystal has been highly desired as a replacement for the laser. [2] l-Serine is an organic compound under amino acid category. It is one of the naturally occurring proteino genic amino acids and it exists in zwitter ionic form. The molecule can combine with anionic, cationic and overall neutral constituents. l-Serine crystal belongs to orthorhombic crystal system with space group$P_{212121}$.[3] A series of metal organic compounds such as $Cu^{2+}$and $Mg^{2+}$doped l-arginine trifluoroacetate crystal, metal ions doped L-lysine monohydrochloride dihydrate single crystal have been reported with improved chemical stability, mechanical and optical proper-ties [4,5]. The aim of the present communication is to study the effect of metal incorporated L-Serine Crystal on the growth, physical and chemical properties that may find wide applications in optoelectronic devices.

## 2. GROWTH AND LINEAR OPTICAL PROPERTIES OF LSPC

The metal incorporated L-Serine Crystal was grown by slow solvent evaporation technique. The photograph of as grown LSPC crystal with the dimension of 10 x 4 x 4 $mm^3$ is shown in Fig-1. The grown crystal was subjected to UV studies that revels that the optical transmittance spectrum of LSPC single crystal is shown in Fig-2. The spectrum indicates that LSPC crystal has minimum absorption in the region between 200–1200 nm. A good optical transmittance is very desirable in an NLO crystal since the absorptions, if any, in an NLO material near the fundamental of the second harmonic will lead to less conversion efficiency in those wavelengths. When absorption is monitored from shorter wavelength to longer wavelength, the enhanced transmission is observed between 300 and 1100 nm. As the entire region does not bear any absorption band it can be used for NLO applications. The values of the direct optical band gap $E_g$ were obtained from the intercept of $(\alpha h\nu)^2$ versus hν curve plotted in Fig-3. Energy gap ($E_g$) was evaluated by extrapolating the linear part of the curve to energy axis. The band gap is found to be 6.33 eV. This value of optical band gap shows blue shift, which is useful for gas sensing applications As a consequence of wide band gap, the crystal under study has a large transmittance window. The bandgap width $E_g$ of crystalline materials depends on their anisotropy, temperature, pressure on effect of external electric and magnetic field forces. The other optical constants were calculated using the theoretical formulae [6, 7].

**Fig -1**: Photograph of as grown LSPC crystal

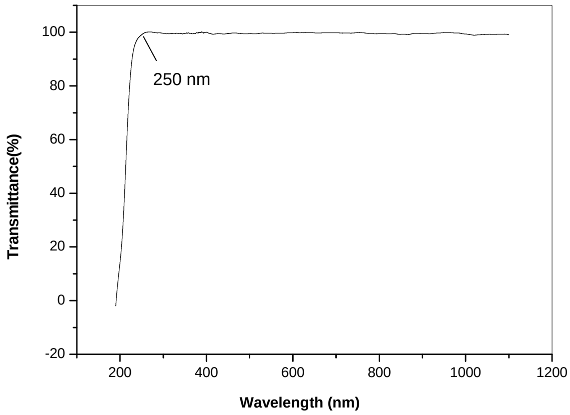


**Fig -2**: Optical transmittance spectrum of LSPC crystal

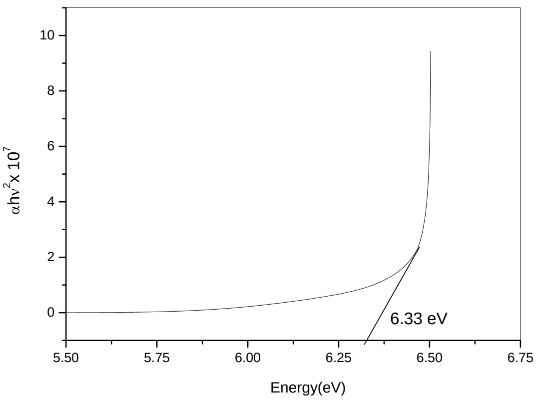


**Fig.3:** Energy band gap curve of LSPC crystal

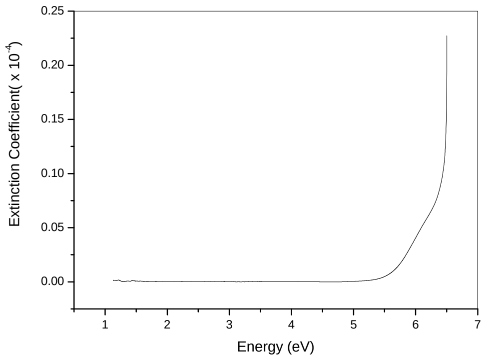


**Fig -4**: Extinction coefficient Vs Incident Photon Energy of LSPC crystal

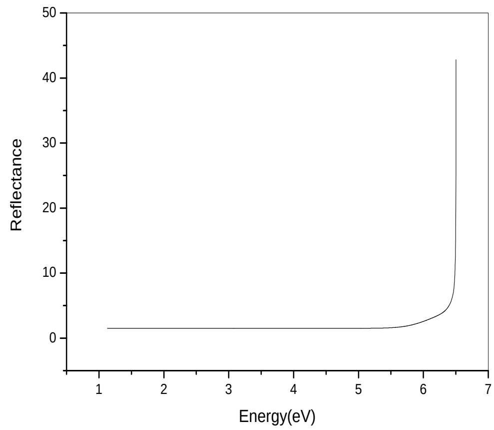


**Fig -5**: Reflectence Vs Incident photon energy of LSPC crystal

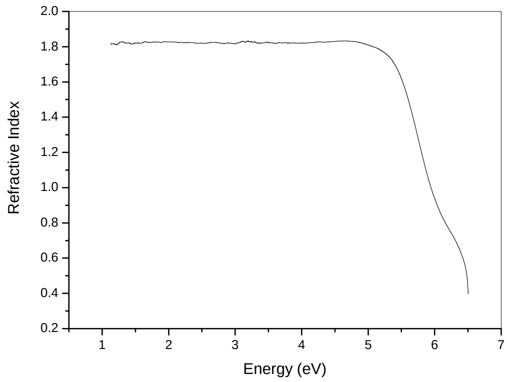


**Fig -6**: Refractive index Vs Incident photon energy of LSPC crystal

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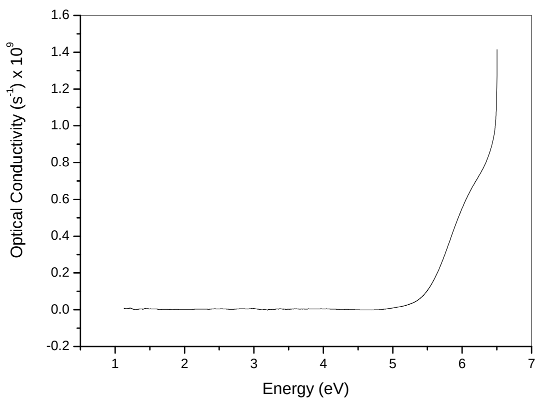


**Fig -7**: Optical conductivity Vs Incident photon energy of LSPC crystal

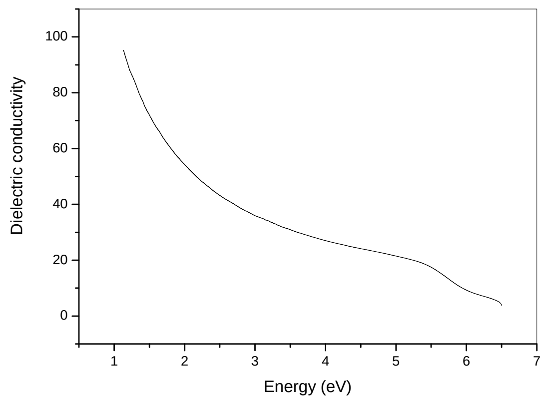


**Fig -8**: Dielectric conductivity Vs Incident photon energy of LSPC crystal

Extinction coefficient Vs photon energy is shown in Fig. 4 and variation of reflectance with incident photon energy is depicted in Fig. 5. Refractive index, optical conductivity and dielectric conductivity as a function of incident photon energy for the grown single crystal are illustrated in Fig. 6, 7 and 8. It is shown that the refractive index and extinction coefficient of LSPC changes with increasing Photon energy. The high transmission or low absorption in the region 300-1200nm makes the material to obtain low reflectance and refractive index which is a suitable property for antireflection coating solar thermal devices and nonlinear optical applications. The low extinction coefficient ($10^{-4}$) and high optical conductivity ($10^{9}$) confirms the high photo response nature of the material [8].

## 2.1 NLO Studies

The grown crystal LSPC were subjected to Kurtz [9] Second Harmonic Generation (SHG) test using the Nd:YAG Q-switched laser beam for the nonlinear optical (NLO) property. The second harmonic signal of 305 mW was obtained for LSPC single crystal with reference to KDP (282 mW). Thus, the SHG efficiency of LSPC single crystal is nearly 1.19 times greater than KDP.

## 3. CONCLUSIONS

Good quality single crystals of LSPC were grown successfully by slow evaporation technique. Its Energy band gap was calculated from Tauc's plot as 6.33 eV. The optical absorption spectrum is used to study various linear optical parameters as a function of incident photon energy. The lower dielectric conductivity and the higher optical response suggest that the material has better conversion efficiency.

## ACKNOWLEDGEMENT

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