Linear Optical Study of ADP and KDP Doped Thiourea Single Crystals

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Abstract— In present investigation pure, ammonium dihydrogen phosphate (ADP) and potassium dihydrogen phosphate (KDP) doped thiourea single crystals have been grown by slow evaporation solution technique at room temperature. The positive influence of dopants ADP and KDP on optical transparency of thiourea single crystal has been evaluated in the range of 200 to 900 nm under UV-visible spectral analysis. The technologically vital optical constants such as optical conductivity, extinction coefficient, refractive index and reflectance have been evaluated using the transmittance data. The results were explored to investigate the nonlinear optical (NLO) device applications of the grown crystals.

Key Words— Ni-Cd ferrites, SEM, Electrical properties, dielectric constant.

INTRODUCTION

THE materials with high nonlinear optical (NLO) response are widely demanded for fabrication of photonics and optoelectronics device applications. Thiourea is an ideal organic structural model with wide π-bonding network which offers large NLO response and asymmetric polarizability [1]. In past decade thiourea (Th) has played key role in developing various semi-organic Th metal complexes such as zinc thiourea chloride (ZTC), cadmium thiourea chloride (CTA), zinc tris-thiourea sulphate (ZTS), bis-thiourea cadmium formate (BTCF) and many more [2]. Recently, urea-thiourea mixed single crystals have been grown and a structural study has been done by Madhurambal et al [3]. In order to tune the structural, optical, thermal, NLO, and morphological properties of Th dye has been doped and irradiation effect of Li^{+3} ion has been studied [4]. As very few studies are reported on doping different materials in Th in present investigation ADP and KDP has been doped in thiourea for the first time in literature and the optical studies has been performed to explore the possible device applications of the grown single crystal.

EXPERIMENTAL DETALS

The AR grade Th has been dissolved in double distilled deionized water to obtain the homogeneous supersaturated solution of Th. The supersaturated solution of Th was taken in two separate beakers and 1wt% of ADP and KDP was added to it respectively. These solutions were allowed to agitate for six hours to achieve the homogeneous doping throughout the medium. The ADP and KDP doped Th solutions were filtered and kept for slow solution evaporation in a constant temperature bath maintained at temperature of 35 ^{0}C. The crystals grown within a period of 2-3 weeks are shown in Fig. 1.

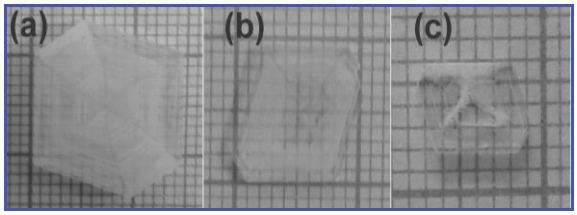

Fig. 1. a) Pure Th, b) ADP doped Th, c) KDP doped Th

RESULTS AND DISCUSSIONS:

UV-VISIBLE SPECTRAL ANALYSIS

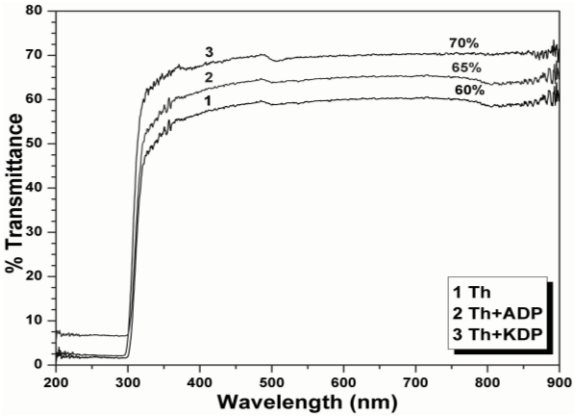

Fig. 2. Transmittance spectrum

The optical transparency of pure and doped Th crystals (1 mm thickness) has been examined in the range of 200 to 900 nm using the SHIMADZU UV-2450 spectrophotometer. The transmittance (T) spectrum shown in Fig. 2 reveals that the transparency of pure Th is 60%, ADP doped Th is 65% and KDP doped Th is 70%. The sharp transmittance cutoff wavelength of crystals near 300 nm indicates the major influence of amine chromospheres [5]. The enhancement in transparency of ADP and KDP doped Th crystals confirm that the optical quality of crystals is good and the crystals are significant for designing laser frequency conversion and optoelectronics devices [6].

DETERMINATION OF OPTICAL CONSTANTS

In order to find the photonics device application of doped Th crystals, the optical conductivity, extinction coefficient, refractive index and reflectance were calculated using the transmittance data using the formulae, $\sigma_{op}= \alpha nC/4\pi$, $K = \alpha\lambda/4\pi$, $n = 1/T+(1/T-1)^{1/2}$, $R = ((1-n)/(1+n))^2$ respectively [7]. The photonic response of optical conductivity and variation of extinction coefficient with reference to wavelength is shown in Fig. 3a and 3b respectively. The extinction coefficient of Th crystal successively decreases with addition of ADP and KDP also the optical conductivity of doped Th crystals increases with incident photon energy. The high optical conductivity factor is essential parameter for designing optical information processing and computing devices [8]. The variation of refractive index and reflectance as a function of wavelength is shown in Fig. 3c and 3d respectively. It is observed that the refractive index and reflectance of Th significantly decreases with addition of ADP and KDP respectively. The lower refractive index of doped Th crystals is most promising quality for calibrating the crucial components such as filters, resonators and reflectors of an optical system [9]. The improved optical transparencies, lower extinction coefficient, lower refractive index and lower reflectance pronounces the usability of doped Th crystals as antireflecting coating material for solar thermal devices [10].

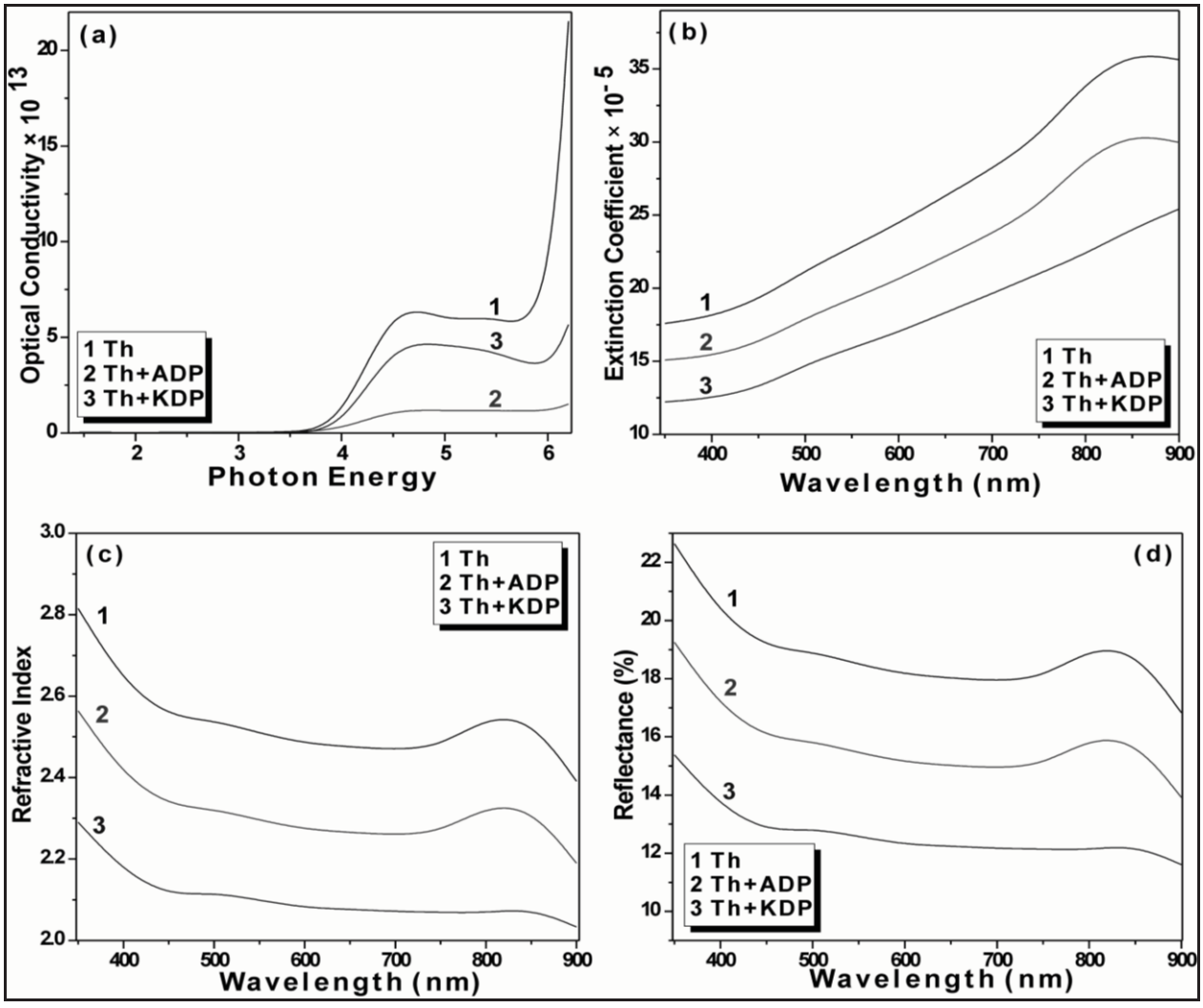

Fig. 3. a) Optical conductivity vs. Photon energy, Variation of b) Extinction coefficient, c) Refractive index and d) Reflectance as a function of Wavelength

CONCLUSION

In present study, pure, ADP and KDP doped Th crystals have been grown by slow evaporation solution technique at the temperature of 35 ^{0}C. The optical study revealed that the transparency of Th crystal significantly enhanced by 5% with addition of ADP and 10% with addition of KDP. The optical conductivity, extinction coefficient, refractive index and reflectance of grown crystals have been calculated. The vital optical constants such as; extinction coefficient, refractive index and reflectance of Th crystal have been reduced due to addition of ADP and KDP respectively. The improved optical transparency, minimized refractive index, reflectance and extinction coefficient of doped Th crystals vitalizes its exclusive utility for NLO, photonics, optoelectronics devices.

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