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Harvesting the KAP Crystal and Study the Influence of Cu^{2+} Ions on the Structural and Optical Properties

[1]Ravindra N. Khule, [2]Sunil N. Botewad
[1,2]Shri Shivaji Arts, Commerce and Science College, Kandhar, Dist. Nanded, Maharashtra-431714 (India).
Corresponding Author Email: ravindrakhule2015@gmail.com (Dr. Ravindra N. Khule)

Abstract: *The influence of doping Cu2+ on the growth process, and crystalline properties of potassium acid phthalate (KAP) has been investigated. Optically transparent single crystals of Cu2+ doped potassium acid phthalate (KAP) were grown in an aqueous solution by slow evaporation technique. Distilled water is used as a solvent. The doped and undoped KAP crystals and their nonlinear properties have been reviewed in the present project. Optical transmission studies were carried out by allowing UV-Visible light of wavelength range 300-900 nm and the results s confirm that both the pure and doped KAP single crystal shows good transparency in the entire visible region, which is suitable for optical device applications. The XRD peak of pure KAP and doped KAP were well matched.*

Index Terms - *KAP crystal, Nonlinear Optics, Slow Evaporation method.*

1. INTRODUCTION

Recently, the second order nonlinear optical (NLO) materials have massively attracted by scientists and researchers because of their potential applications in the promising area such as photonics, laser induced technologies and opto-electronics. Materials with large second order optical nonlinearities find wide applications in optical communication, telecommunication, optical information processing and data storage devices because the magnitude of this quantity dominates the device performance, solid-state lasers, frequency conversion, image processing, data storage, fiber optic communication, etc. Moreover, recently, a variety of semi-organic crystals for NLO applications have been developed. They are essential for the development of advanced modern technologies ranging from telecommunication, signal processing, data storage, super-resolution lithography, and microscopy to higher harmonic and terahertz (THz) generation [1-4]. In particular, NLO materials with well-defined architectures on the (sub)wavelength length scales are regarded as key materials for the development of the next generation integrated photonic circuits [4]. Semi-organic crystals have attracted considerable interest due to their large nonlinear optical coefficients, high resistance to laser induced damage, low angular sensitivity and excellent mechanical hardness [5]. Potassium Acid Phthalate (KAP) single crystal is an interesting non-linear optical material. KAP single crystals exhibit excellent physical properties and also piezoelectric, pyroelectric and nonlinear properties [6]. Therefore, crystals of KAP are selected for the present project. Good quality single crystals of KAP were grown by slow evaporation technique. The addition of some transition metal ions as impurities is expected to influence the growth kinetics, habit modification as well as growing the large size single crystal. The presence of small entity of impurities such as Ni2+, Mg2+, Co2+ and Li+ plays a vital role on the growth rate, habit of the crystal and its properties (7).

In the present work, we have grown KAP crystals by doping Cu2+ and investigated the effect of it on the various properties of crystal by characterization methods UV-Vis. spectroscopy and XRD.

2. EXPERIMENTAL

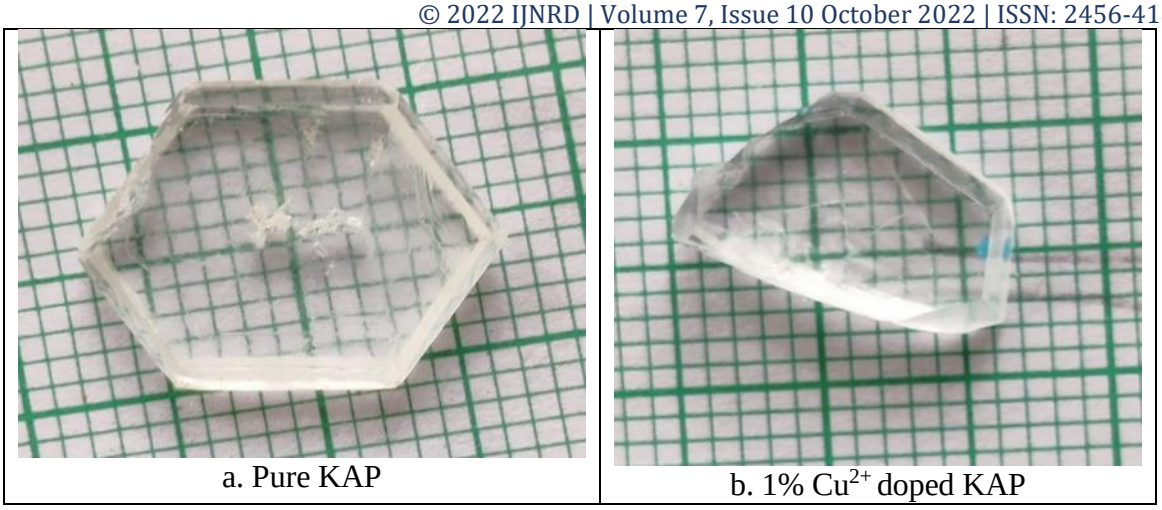
2.1 MATERIALS AND CHARACTERIZATION

Harvesting the KAP and Cu^{2+} doped KAP crystals analytical grade purity of potassium acid phthalate and copper sulphate were used. The potassium acid phthalate and copper sulphate were purchased from Sd fine chem. India. The structural properties studied by X-ray diffractometer (XRD) (Mini Flex II, Rigaku, Japan) with CuKα radiations of wavelength 1.5406 Å. The ultra-violet-visible (UV-Vis.) portable spectrophotometer BLACK-Comet-SR (Stellar Net, USA) was used to study the optical properties.

2.2 SYNTHESIS OF CDS AND L- ASCORBIC ACID DOPED NANOPARTICLES

The KAP crystal was synthesized by dissolving the pure Potassium Acid Phthalate (KAP) in distilled water. The solution was stirred using magnetic stirrer and then kept in the constant temperature water bath. Transparent colorless crystals of KAP were obtained in 5-6 days.

Single crystals of KAP and Cu^{2+} doped KAP were grown by slow evaporation method. For the growth of Cu^{2+} doped KAP crystals, 1 mol percent of Cu^{2+} was added to the solution of KAP and then the solution is stirred using magnetic stirrer, kept in the water bath. The doped crystals were harvested in 4-5 days. After recrystallization of both the doped and undoped crystals the pure crystals are obtained in about 1-2 weeks. The grown crystal of pure and doped KAP by slow evaporation method is shown in fig.1.



a. Pure KAP | b. 1% Cu^{2+} doped KAP

Fig 1: Photograph of KAP crystal

3. RESULT AND DISCUSSION

3.1 STRUCTURAL PROPERTIES (XRD)

The powder XRD pattern of pure KAP and Cu^{2+} doped KAP crystal have been recorded using X-Ray Diffractometer (Rigaku Miniflex II, Japan). From the XRD data it is observed that both pure and Cu^{2+} doped KAP crystals are crystallized with orthorhombic system and space groupPca21. The recorded XRD pattern is as shown in following figure 2.

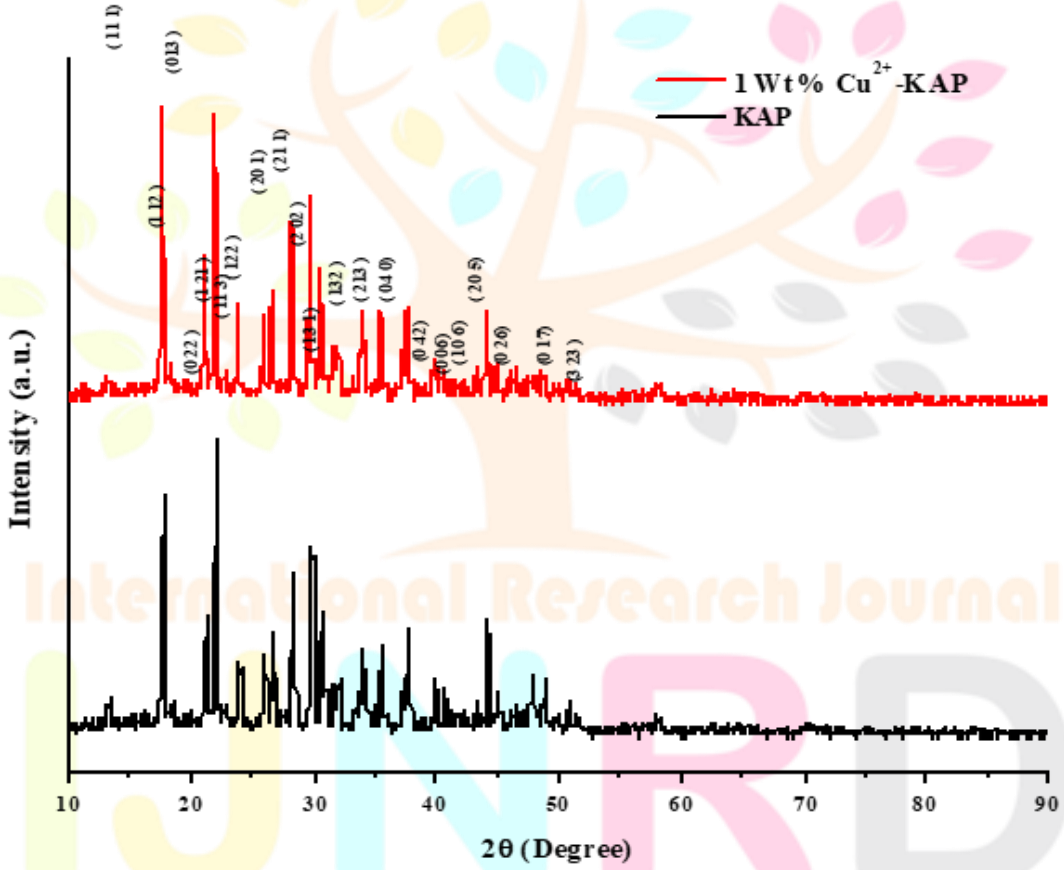


Fig.2 Powder XRD pattern of nanoparticles of CdS

The lattice parameters of Pure KAP are shown in the table 1. Table 1. Shows the KAP crystal have the lattice parameters A = 9.752, B = 13.224 and C = 6.610 with 852.42 as volume of unit cell.

Table 1. Lattice parameters of Pure KAP crystal

Lattice Parameters	Pure KAP (Å)
A	9.752
B	13.224
C	6.610
Volume of unit cell ($Å^3$)	852.42

3.2 UV- Vis. study

The UV-Visible Spectroscopy for the KAP has been performed by using UV-Visible Spectroscopy (Black-Comet-SR, Stellar Net Incl. USA). The thin polished slice of single crystal has been used in the characterization. The transmission has been measured over the wavelength range 300nm to 900nm.The maximum transmittance for pure KAP is found at 637nm which is 57% and the maximum transmittance for Cu^{2+} doped KAP is found at 662 nm wavelength which is 86%. This shows that the transmittance of the crystal has been increased because of doping. The transparency of crystal due to doping increases. The transmittance spectra show the grown crystals have lower cut-off wavelengths at around 300nm. The grown KAP crystal has good transmission in UV as well as in visible region.

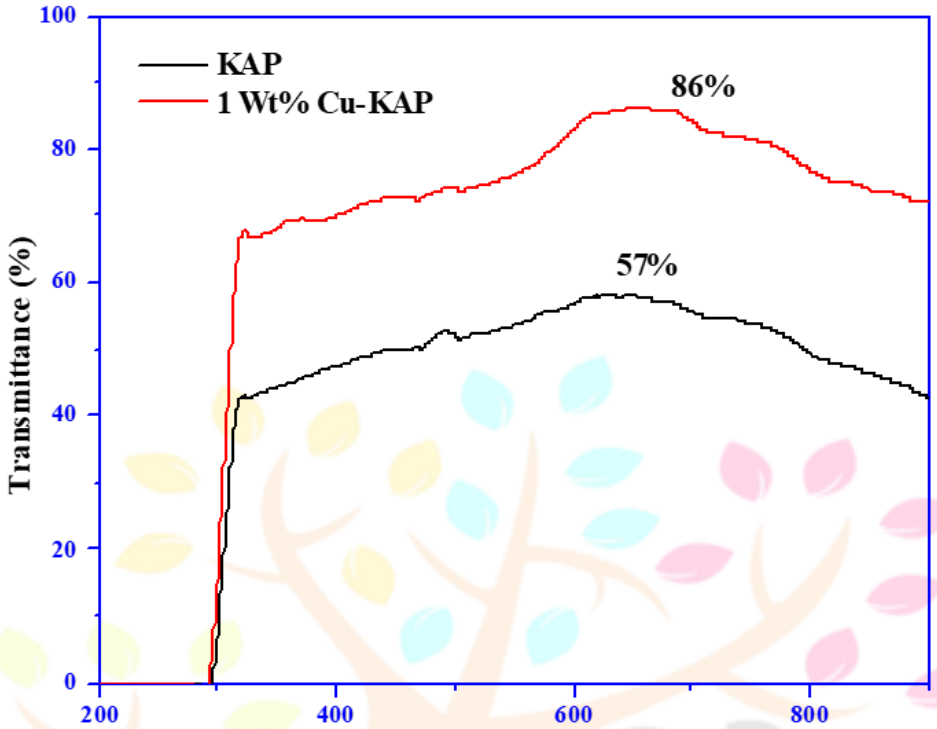


Fig. 3 Transmittance spectrum of undoped and doped KAP Crystals

4. CONCLUSION

Transparent, Colourless crystal of Potassium Acid Phthalate was successfully grown using Low Temperature Solution Growth method by Slow Evaporation. From the above characterisation techniques and result we conclude that the grown crystal of KAP is efficient and with the addition of dopant it's efficiency and transparency has been increased. The Cu^{2+} doped crystals have high transmittance in the Visible region and hence it acts as a good candidate for optical applications. The UV-Visible study revealed that the transmittance of the doped crystal has increased than the undoped crystal. All these studies reveal that the presence of metallic dopants enhance the optical properties of the KAP crystals and thus considered as potential candidates for the fabrication of electro-optic, nonlinear optical and optoelectronic devices.

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