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Growth and Characterization of KDP and Bimetallic doped (Ni^{3+},Mg^{2+}) KDP Crystals

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Abstract: The field of non-linear optics offers a host of fascinating phenomena of which some are eminently useful. The growth of single crystal has been made by growing pure KDP (Potassium Dihydrogen Phosphate) with dopants of Ni^{3+} and Mg^{2+} by slow evaporation solution growth technique and their desired change in properties were analysed. In FTIR spectrum, the frequency shifting confirms the incorporation of ions into the crystal lattice. The transmittance and absorbance spectrum for pure KDP and bimetallic KDP crystal is recorded by UV-Visible spectral analysis. The XRD pattern of both pure KDP and bimetallic KDP had three prominent peaks at (200), (112) and (321) and also change in the peak intensity was observed. The strength of the grown crystals was verified by Vicker's microhardness measurements. NLO property is studied by Kurtz method which confirms the second harmonic generation. Doping of KDP with Ni^{3+} and Mg^{2+} are the promising material for optical harmonic generation.
Keywords: Growth and Characterization of KDP and Bimetallic doped (Ni^{3+},Mg^{2+}) KDP Crystals.

Introduction

Potassium dihydrogen phosphate(KDP) is an interesting inorganic crystal well known for its desired NLO property, frequency conversion, UV transmission [1] which enhances the development in the field of photonics. Inorder to enrich the properties of KDP suitable single dopant element like TiO_2, Cr^{3+} [2] has been added and characteristic changes were analysed. In the present study an effort has been made in growing KDP with addition of bimetallic dopants of Ni^{3+} and Mg^{2+} by slow evaporation growth technique. The grown crystals are subjected to various spectral analysis like FTIR,UV-Visible, XRD and Vicker's hardness test.

Experimental Procedure

Pure KDP and Ni^{3+},Mg^{2+} added KDP crystals were grown by slow evaporation growth technique at room temperature. The saturated solution is prepared by dissolving the solute of KDP in 26g per 100ml in distilled water. Then the dopants are added in to the solution of pure KDP which reduces the solubility. After a few days, seed crystals were seen at the bottom of the grown beaker.Then the grown crystals has been subjected various spectral studies to analyse its characteristics.

Results and Discussion

i) FTIR spectrum

FTIR spectrum for pure KDP and KDP doped with Ni^{3+},Mg^{2+} were recorded using Perkin Elmer model spectrometer in the range of 4000-400 cm^{-1}. The recorded FTIR spectrum for doped KDP is shown in figure 1.1.

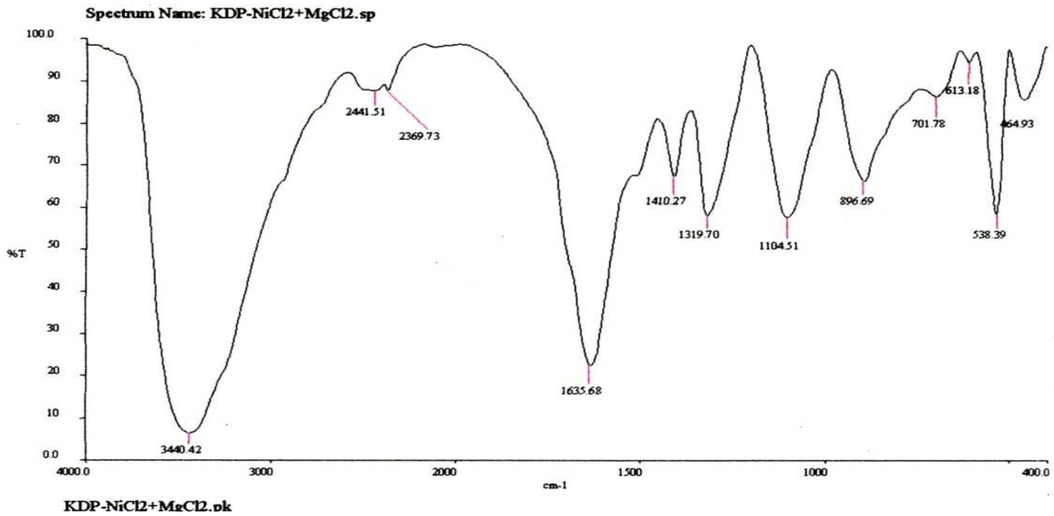

Figure 1.1 FTIR spectrum of Ni^{3+},Mg^{2+} doped KDP crystal

The O-H stretching modes for pure KDP occurs at 2369.73cm^{-1} whereas for bimetallic doped KDP occurs at 2369.88cm^{-1}. In the grown KDP crystal the orthophosphate ion was observed at 459.03cm^{-1} whereas for the doped KDP is 464.93cm^{-1}.This study clearly indicates the effect of dopants [3]on the crystal lattice.

ii) U-V Visible Spectral Analysis

UV-Visible spectrophotometer was used to record the UV-Visible spectrum for single crystals of pure KDP and bimetallic doped KDP crystals in the range of 190 – 1100 nm. The lower cut off wavelength of the pure KDP and bimetallic KDP crystal occurs at 200 nm.The optical transparency lies in the range of 350-1100 nm facilitates to be a potential NLO material.

iii) X-Ray Diffraction Studies

XRD pattern for KDP and bimetallic doped KDP crystals is obtained by a graph drawn between the intensity and 2ɵ. The large strongest peak at 23.32 for pure KDP and 24.180 for bimetallic doped KDP is the 100% peak.

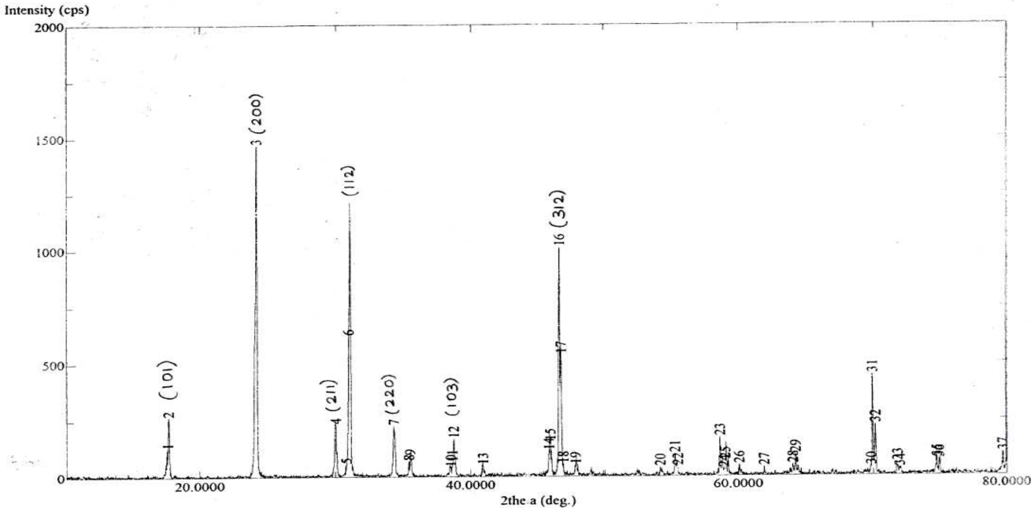

Figure 3.1 XRD pattern for (Ni^{3+},Mg^{2+}) doped KDP crystal.

The X-ray diffraction pattern for bimetallic doped (Ni^{3+},Mg^{2+}) KDP is shown in the Fig 3.1. The XRD patterns of doped KDP crystal have the same diffraction peaks as pure KDP but some additional peaks and change in the peak intensity were observed. The XRD pattern of both pure KDP and bimetallic KDP had three prominent peaks at 200,112 and 321 respectively as reported [6].

iv) **NLO Property**

The conversion efficiency of the crystal was checked by Kurtz and Perry method. The crystal was ground into powder and densely packed between two glass slides. Then Nd: YAG laser beam of wavelength 1064 nm was made to fall normally on the sample and colour of beam changes from red to green.

v) **Microhardness Measurements**

The strength of the grown crystals were verified by microhardness test. They were indented using microhardness tester fitted with a Vickers pyramidal indenter.An indentation time of 10 sec were applied uniformly for the load between 25 gm to 100 gm. The hardness value of the KDP crystal was found to be 105 at 100 gm of load whereas for doped KDP it is 146. Hence hardness value increases [7] on the addition of dopants added.

Conclusion

Single crystals of pure KDP and bimetallic doped KDP crystals were grown by solution growth technique and their change in properties were analysed. In FTIR spectrum, it was found that there is a frequency shift which confirms the incorporation of ions. The transmittance of KDP increases by the doping material was inferred by UV studies. In the XRD analysis shift in peak intensity was observed due to the incorporation of dopants. The mechanical property of the crystal was studied by Vicker's hardness test. Its non linear optical property had been studied by Kurtz powder method.

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