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# Raman Study of Sodium Potassium Sulphate Crystals☆

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**Abstract**

The growing interest in the physical properties of double sulphate crystals is due to the fact that they show anomalous behavior at transition points (M.E.Kassem et.al., 1984). Sodium potassium sulphate is a member of the family of crystals having the general formula M′M″$BX_4$ (where M′ stands for Na or Li M″ stands for K, Na, Rb, Cs ammonium ($NH_4$) or hydrazine ($N_2H_5$) and $BX_4$ stands for $SO_4^-$ or $SeO_4^-$ (M.E.Kassem et.al., 1984).



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*Keywords:* , Solution method , Sodium Potassium Sulphate Crystals, Raman Spectra, Vibrational Assignment, Raman Study



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**1. Introduction**

Solids exhibiting ionic conductivities comparable to those of melts or liquids are referred to as superionic conductors (SIC's) or solid electrolytes. These fast ion conductors have attracted considerable attention because of (i) their promise in applications in high energy density batteries and (ii) their unusual transport behavior. Also ($Na,K_2SO_4$) compositions have been suggested as potential electrolytes in applications for $SO_2$ detectors (M.Sunitha kumari et.al., 1983).Their importance arises from the fact that some double sulphate crystals display ferroelectric and ferroelastic behavior in different temperature ranges. Studies of these ferroelectric and ferroelastic materials are important for their use as piezoelectric compounds and pyroelectric detectors and in the memory of computers (M.E.Kassem et.al., 1989).

The pyroelectric,dielectric properties and shear modulii $G_x^3$, $G_y$, and $G_x$ as well as the internal internal fraction of $Q^{-1}$ of $NaKSO_4$ crystals were studied in the temperature range from 100 upto 300 K. An inverted torsion pendulum technique was used to determine the temperature dependence of both shear modulii and internal fraction. The results of the pyroelectric measurements are in the agreement with the centrosymmetric class of $NaKSO_4$. The variation of dielectric constants with temperature shows two segments with different slopes. Anisotropic behavior in the temperature dependence of the shear modulii was also observed. The internal friction showed a pronounced maximum in Z-direction at 200K. It is well known that $NaKSO_4$ crystals have orthorhombic symmetry at 300K and belong to the mmm point group The growing interest in studying the physical properties of the double sulphate crystals is due to the fact that they show anamolous behavior at different phase transition temperature ( 2-5). The recently obtained results of thermal studies of $NaKSO_4$ crystal (6) in the temperature range from 300 to 500K point out the existence of a structural phase transition in these crystals at 453K.

**2. Experimental Procedure**

**Growth of crystals**

Good crystals of sodium sulphate ($Na_2SO_4$) were obtained by using aqueous solution method. For $Na_2SO_4$ crystals, sodium sulphate solution was prepared for one molar concentration by dissolving 1.432 gms of sodium sulphate powder with 10ml of distilled water. For $K_2SO_4$ crystals, potassium sulphate solution was prepared for one molar concentration by dissolving 1.743 gms of potassium sulphate powder with 10ml of distilled water. The required quantity of sodium salt and potassium salt are weighed by Schmidzu type electronic balance ( model AY 220). Both the solutions were mixed well using (REMI model) magnetic stirrer. Final solution was kept in a wooden box to avoid an environmental pollution such as humidity, temperature, and pressure. The period for the growth of good crystal is 7-10 days.

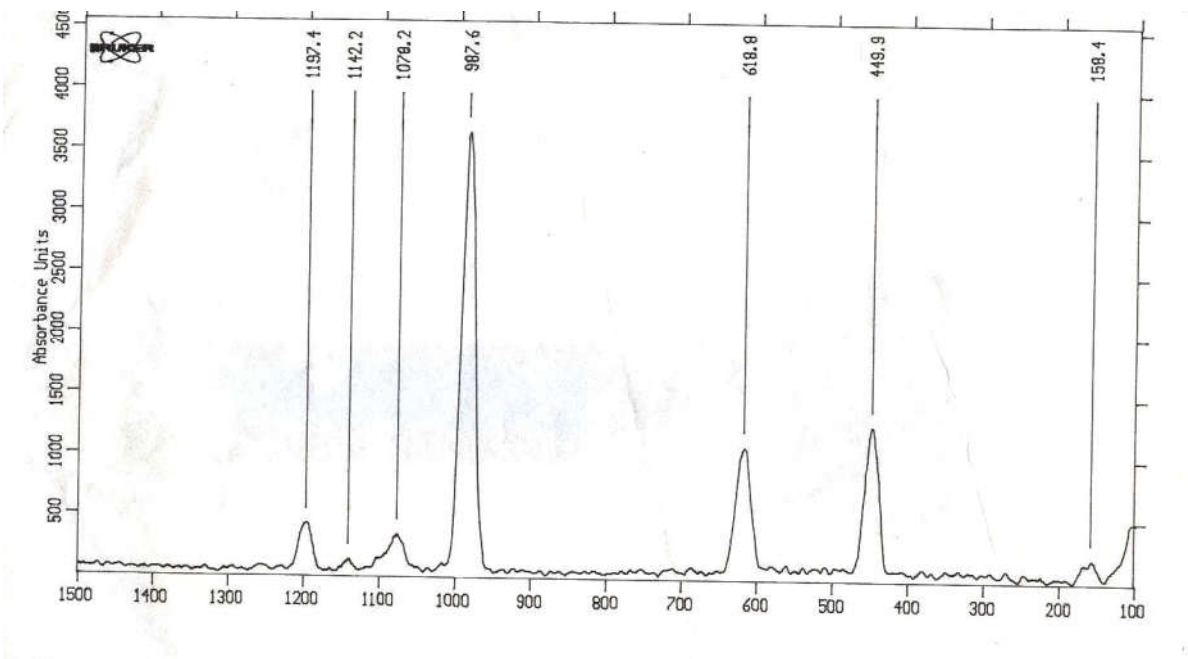


**Fig. Laser Raman spectrum of Sodium Potassium Sulphate (SPS) crystal**

**Table.1.Raman assignments of Sodium Potassium Sulphate (SPS) crystals**

| Raman($cm^{-1}$) | Assignments |
|---|---|
| | $\nu_1 H_2O$ |
| | $\nu_3 H_2O$ |
| | $\nu_3 H_2O$ |
| | $\nu_2 H_2O$ |
| 1197.4 | $\nu_{as} SO_4$ |
| | |
| 1142.2 | $\nu_{as} SO_4$ |
| 1078.2 | $\nu_{as} SO_4$ |
| 987.6 | $\nu_{as} SO_4$ |
| 618.8 | $\nu_{sb} SO_4$ |
| | |
| 449.9 | $\nu_{sb} SO_4$ |
| 158.4 | $\nu_{ab} SO_4$ |

**Raman Study**

The peaks observed at 1197.4 $cm^{-1}$, 1142.2 $cm^{-1}$, 1078.2 $cm^{-1}$ are assigned to asymmetric stretching of $SO_4$ molecule. The value of 1197.4 $cm^{-1}$ is agreed with the value obtained by H.K. Liu et al at 1205 $cm^{-1}$ in their study of Raman studies of the low temperature phase transition in $LiKSO_4$ which is similar group of $NaKSO_4$ .The peak observed at 987.6 $cm^{-1}$ is attributed to symmetric stretching of $SO_4$ molecule. Asymmetric bending of the $SO_4$ molecule is obtained at 618.8 $cm^{-1}$. Symmetric bending of $SO_4$ molecule is obtained at 449.9 $cm^{-1}$ in which the value of 445 $cm^{-1}$ of H.K.Liu in his study. The Laser Raman spectrum is shown in figure

**Conclusion**

The asymmetric stretching of $SO_4$ groups obtained in the frequency range of 1197.4 $cm^{-1}$ is the evidence of low temperature phase transition in $LiKSO_4$ which is similar group of $NaKSO_4$ which means the double sulphate crystals have a low temperature phase transition property

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