CHAPTER-V

: SUMMARY AND CONCLUSIONS :

***

CHAPTER-V

SUMMARY AND CONCLUSIONS

Ferroelectric materials have been extensively studied in theory and in experiment during the last few years. These materials are becoming a useful and vital component of the latest technology, microelectronics and quantum electronics. Because, firstly they have large value of the absolute dielectric constant (permittivity) and secondly, their non-linear optical properties can be used for the multiplication of optical frequencies and the deflection and modulation of laser and other light.

Ferroelectrics continue to arouse interest among the research workers as they hold promise in diverse new areas of technology and their understanding is not yet complete. Sodium vanadate and potassium vanadate are ferroelectrics which can be studied by using various techniques such as X-ray diffraction, neutron diffraction, Raman spectroscopy, NMR, electron microscopy etc.

In the present problem , we studied the ferroelectric properties of sodium vanadate and potassium vanadate such as dielectric hysteresis, solid-state battery formation and second harmonic generation (SHG) and TANDEL effect. The result of the above studies have been presented in the chapters II, III and IV of this dissertation.

In order to prepare the samples, the molten minture of V_2O_5 and Na_2CO_3 or K_2Co_3 having molar propertion 1:1 at 750^{o}C is allowed to cool slowly; so that we get crystalline solid. This crystalline solid is then powdered in the mortar and pellets are prepared. A pressure of 5 tone is given on the pellet-dye by means of Brahma's pressure machine. After sintering, the pellets can be used for experimental purpose.

A modified form of Sawyer and Tower circuit (1930) was used for studying dielectric hysteresis. The shapes of hysteresis curves were observed on the oscilloscope screen at various temperatures and photographs were taken. From these photographs as shown in the figures (2.3) and (2.4) in the Chapter II, we can conclude that the shape of hysteresis curve is temperature dependent. At room temperature we can not see the hysteresis loop but at higher temperatures the hysteresis loops of irregular shapes were observed. At Curie temperature the hysteresis loop disappears and again reappears when the sample is cooled. These observations lead us to the following conclusions:

a) The loss is small at room temperature.

b) The hysteresis loop suddenly broadens and becomes angular at a certain temperature i.e. the shape of hysteresis loop is irregular.

c) The loss vanishes at Curie temperature.

d) Ferroelectric properties of $NaVo_3$ can be observed below 380^{o}C as reported by Sawada et al (1951).

e) The ferroelectric properties of KVo_3 can be observed below 312^{o}C.

For the formation of solid state battery, a d.c. electric field of about 1 KV/Cm is to be applied to the sample at high temperature and then taken off. This generates electromotive force across two platinum electrodes of the crystal holder which is to be measured. The graphs of e.m.f. versus temperature as shown in the figures (3.2) and (3.3) under Chapter III, clearly show that e.m.f. is temperature depandent. It disappears at low temperatures but recovers when the samples are heated again. A drastic change in the e.m.f. is observed at Curie temperature.

The dependence of second harmonic voltage on d.c. bias was investigated for sodium vanadate and potassium vondate TANDELS (Thermoautostabilized non-linear dielectric elements; Glanc et al (1963) at a frequency of 10 KH_z . For various TANDELS, it was found that the critical peak voltages at which TANDEL behaviour could be observed; were different. By observing the graphs of the second harmonic voltage response for these TANDELS as shown in Figures (4.4) and (4.5) under Chapter IV, we come to know that the second harmonic voltages generated are linear with the applied d.c. voltage for low biasing fields, but for higher d.c. bias second harmonic voltage decreases suddenly indicating destabilization of the TANDELS. This is in agreement with the results of Mansingh and Eswar Prasad (1977) and Chavan and Patil (1980). Our results establish that NaVo and KVo_3 TANDEL elements provide the autostabilized state and this would make them interesting from the point of view of various applications.

The dielectric hysteresis studies show that $NaVo_3$ and KVO_3 are the ferroelectrics below 380° and 312°C respectively. The hysteresis loops of these materials are irregular. These materials are the members of family of miscellaneous complex double oxide having perovskite type of structure and displacive type of transition.

From solid state battery formation studies, we arrive to the conclusion that the application of d.c. electric field of about 1 KV/Cm to the material at high temperature generates some electromotive force which is the indication of formation of solid state battery. This battery gives the large emf at Curie temperature and disappears at low temperature.

The review of the SHG studies of $NaVo_3$ and KVo_3 compel us to think that large second harmonics can be generated at autostabilized state of materials. That means the vicinity of Curie temperature, these materials give large second harmonic voltages.

-000-