

CHAPTER - 5

DIELECTRIC PROPERTIES OF GEL GROWN KDP CRYSTALS

5.1 INTRODUCTION:

A ferroelectric crystals is defined as a crystal which belongs to the pyroelectric family and shows a spontaneous electric polarization and whose direction of polarization can be reversed by an electric field. Experimentally the reversal of spontaneous polarization in ferroelectrics is observed as a single loop, when a low frequency ac field of a suitable strength is applied. However the polarization is a necessary but not a sufficient condition for ferroelectricity. In other words ferroelectricity is a concept based not only upon crystal structure but also upon the dielectric behaviour of crystal. It is a common dielectric character of ferroelectrics that in a certain temperature range the dielectric polarization is observed as a two valued function of the electric field strength. In general, the spontaneous polarization in ferroelectrics can be considered as a structural perturbation on a nonpolarized crystal.

For a parallel-plate capacitor (Say) with a given material between the metal plates the relative permittivity is the ratio of the capacitance observed (C_m) to the capacitance (C_0) if the material were removed (free space between the plates) i.e. $\epsilon_r = C_m/C_0$. Relative permittivity measures the effect of a material on an

electric field relative to free space. It is equal to ϵ/ϵ_0 , Where ϵ is the (absolute) permittivity of the material and ϵ_0 , the permittivity of free space (the electric constant). An early term for relative permittivity was dielectric constant. The unit of ϵ is farad meter⁻¹ (Fm⁻¹). The permittivity of free space, ϵ_0 , has the value 8.854×10^{-12} Fm⁻¹.

5.2 EXPERIMENTALS:

For the measurement of dielectric constant the undoped single crystals of three different sizes were selected. To each crystals silver paste was applied on any two opposite faces. The same crystals were used as samples. Using LCR bridge (type 921) capacitance was measured at one particular frequency for each crystal. The same procedure was used for doped crystals. But here, two KDP crystals having different dopant, (i.e. nickel and cobalt) were used as samples.

For each crystal, its area and thickness were measured. And then using the formula

$$\epsilon = \frac{11.3 \times C_x \times t}{A}$$

dielectric constant was measured.

Where C_x - Capitanace of the sample,
t - Thickness of the sample,
A - Area of the sample.

5.3 RESULT AND DISCUSSION:-

The capacitance obtained at one particular frequency for the undoped crystals and doped crystals along with losses is given in the following table.

TABLE - 5.1

Sample	Frequency	Capitance	Dielectric constant	Losses
Undoped KDP A = 0.541 cm ² t = 0.2 cm	1KH _z	12 pF	50.12	< 1%
Undoped KDP A = 0.261 cm ² t = 0.2 cm	1 KHz	8 pF	69.27	< 1%
Undoped KDP A = 0.363 cm ² t = 0.29 cm	1 KHz	8 pF	72.22	< 1%
KDP doped with nickel A = 0.427 t = 0.29 cm	1 KHz	20 pF	245.58	< 1%
KDP doped with Cobalt A = 0.312 t = 0.415	1 KHz	25 pF	375.76	< .5%

According to published literature⁽¹⁾ the value of dielectric constant for undoped KDP Crystals at room temperature is 50. The calculated mean value (63.87) of dielectric constant for an undoped KDP crystal slightly differs from the value reported in the literature. The values of dielectric constant for doped crystals

are different and higher than that of undoped crystal. This might be due to the impurities present in the crystals.

5.4 CONCLUSION:

The dielectric constant at one particular frequency (1KH_z) for three undoped crystals was found to be approximately same. For doped crystals the values of dielectric constant were found to be different and greater than that of undoped crystals.

REFERENCE:

1. Ferroelectric crystals by Franco Jona and G. Shirane
Pergamon Press,
Oxford London, New York, Paris 1982.