Dynamic properties of the Mitsui model with transverse field. Application to the Rochelle salt crystal

R. Levitskii[a], A. Andrusyk[a] and I. Zachek[b]

[a] *Institute for Condensed Matter Physics of the National Academy of Sciences of Ukraine, 1 Svientsitskii Str., 79011 Lviv, Ukraine, E–mail: aaz@icmp.lviv.ua*

[b] *Lviv Polytechnic National University, 12 Bandera Str., 79013 Lviv, Ukraine*

We study dynamic dielectric response of the Mitsui model with consideration for transverse field. This field occurs due to dynamic flipping of ordering structure elements between two equilibrium positions.

Applying the Mitsui model to Rochelle salt, we additionally take into account piezoelectric interaction with shear strain ε_4. We carried out our study within the Bloch equations method. We derived the expression for dynamic dielectric permittivity, which, generally, consists of six modes. These modes could be of relaxation or resonance type depending on temperature and theory model parameters. In paraelectric phases number of modes reduces to three. Dynamic dielectric permittivity of the Mitsui model without consideration for transverse field consists of only two relaxation modes. Applying the developed approach to Rochelle salt, we used theory model parameters derived earlier under condition of agreement of theory and experiment for thermodynamic characteristics. We derived that only one relaxation mode reveals itself in microwave region in case of Rochelle salt. The contribution of other modes to the dielectric dispersion is negligible in microwave region. Hence the dielectric permittivity is strictly of relaxation (Debye) type as experiment shows.

Increasing frequency leads to redistribution of modes contribution to the dielectric permittivity. So, at $T = 80$K (low temperature paraelectric phase) one resonant mode becomes dominant and sharp peak on the imaginary part of dielectric permittivity at $8{\cdot}10^{12}$Hz appears. Increasing temperature smooths resonant peak. Similar behaviour of dielectric permittivity was observed on experiment. However, experiment shows resonant peak at much more lower frequencies, namely $6.6{\cdot}10^{11}$Hz. Yet we can't explain such discrepancy. We performed a comprehensive research of dynamic permittivity dependence on transverse field. Similarly, we studied dynamic dielectric permittivity of $RbHSO_4$ crystal.