Statistical theory of $Rb_{1-x}(NH_4)_xH_2PO_4$ type ferroelectrics with competitive short-range and long-range interactions

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We have proposed a pseudospin model for $Rb_{1-x}(NH_4)_xH_2PO_4$ type mixed crystals, which takes into account the energy levels of protons around the PO_4 group, a long-range interactions between the hydrogen bonds, and an internal random deformational field. Within the framework of a four-particle cluster approximation we have derived a system of equations for the variational parameters, and also expressions for spontaneous polarization, molar heat capacity, Edwards-Anderson parameter, static longitudinal and transverse dielectric permittivities. Within the Glauber dynamics approach we have studied the temperature behavior of dielectric permittivities of these compounds at different frequencies. It is shown, that results of calculation of physical characteristics of these materials within proposed theory satisfactorily agree with experimental data, with the exception of phase transition regions and intermediate composition regions. Absence of reliable experimental data for the physical characteristics of the $Rb_{1-x}(NH_4)_xH_2PO_4$ type crystals in a wide composition range creates large difficulties for verifying the validity of the proposed theory. We have pointed on necessity of taking into account of piezoelectric coupling to explain temperature and frequency dependence of the dielectric permittivities in mixed crystals.

References

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