Dielectric properties of loparite

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Physical properties of loparite (mineral loparite-Ce approved by IMA rather recently, in 1983 [1]) are insufficiently studied. The structure of this mineral is also under discussion. This mineral belongs to the perovskite structure type with the common formula ABO_3, where several cations with different valencies are in both A and B sublattices. This report presents results of studies of the dielectric response of loparite single crystals from Khibiny alkaline massif, Kola Peninsula (Marchenko peak) in wide frequency and temperature ranges.

The dielectric response of loparite single crystals was measured with a LCR-meter Good Will LCR-819 using the impedance meter schema; the measuring voltage amplitude was 1V, the frequency range was from 10Hz to 100kHz. Samples in the form of thin plates (8.0x8.5x1.85 mm^3) were cut from oriented loparite single crystals. Silver paste deposited on the sample surface was used as electrodes. The studies were performed under conditions of cooling from 650 to 80K with a mean rate of 1-3K/min. Temperature dependences of capacity c and resistance R at different frequencies were measured, which allowed us to obtained the imaginary and real parts of the dielectric response in the temperature range studied.

Analysis of experimental data has shown that there are two characteristic regions in the temperature behavior of dielectric response of loparite single crystals. In the interval from 80 to 200K there are no temperature and frequency dependences. Above 200K a significant growth of dielectric permittivity ε' with a considerable frequency dispersion (in the vicinity of room temperature the minimum and maximum ε' differ by 4 orders of magnitude) is observed, which is due to conductivity. The growth in dielectric permittivity in the region of high temperatures agrees with the increase in conductivity that reaches 10^{-4} $Ohm^{-1}cm^{-1}$ in the vicinity of 600K. The magnitude of ε' at temperatures below 200K as well as the absence of a strong temperature dependence allows us to classify loparite crystals as dielectrics in this temperature interval. The temperature dependences of ε' at T > 200K exhibit two anomalies the shapes and positions of which are essentially frequency-dependent. It can be supposed that these frequency-dependent anomalies can be attributed to two different relaxation mechanisms caused by disorder in the A and B loparite sublattices.

Possible relaxation mechanisms responsible for the anomalies in the dielectric response of the compound are analyzed. Comparison with the behavior of the dielectric response of complex (partially disordered) artificially synthesized perovskites where similar anomalies are observed is given.

[1] Mineral database mindat.org http://www.mindat.org/min-2432.html