American Mineralogist, Volume 96, pages 860–863, 2011

Electrical properties of natural and synthetic nano-crystalline $MgTiO_3$ geikielite at mantle pressure and temperature conditions

G. Parthasarathy*

National Geophysical Research Institute, Council of Scientific and Industrial Research, Hyderabad-500007, India

Abstract

Electrical resistivity of synthetic nanocrystalline (30–40 nm crystallite size) and a crystalline natural sample of geikielite $MgTiO_3$ has been measured at simultaneous high pressure and high temperature up to 6 GPa and 800 K, respectively. The temperature dependence of the electrical resistivity of both the synthetic and natural sample obeys the Arrehenius behavior in the temperature range between 3 and 800 K and pressure range up to 6.0 GPa. The activation volume of the electrical conduction for coarse crystalline natural sample of geikielite is almost twice that of the synthetic nanocrystalline geikielite indicating the increase of activation volume with the crystallite size. The activation energy for the electronic conduction decreases from 0.39 eV at room pressure to 0.25 eV at 6.0 GPa for natural geikielite, and 0.68 to 0.225 eV in the same pressure range for synthetic geikielite. The pressure dependence of the activation energy of geikielite sample is found to obey the following expressions

ΔE (eV) = 0.39 – 0.026(1) P + 0.0036 P^2 for natural sample, and
ΔE (eV) = 0.68 – 0.080 (2) P + 0.0007 P^2 for synthetic sample,

where P is pressure in GPa. We observe a crossover from extended state type conduction to hopping conduction at 4.0 GPa and 350 K for nano-crystalline geikielite. However, there is no such change of conduction mechanism observed for the natural geikielite at high pressures and high temperatures. The present study reveals the phase stability of nano-crystalline geikielite and natural geikielite up to mantle pressure and temperature conditions, viz. 6 GPa and 800 K, and no phase transition or decomposition is observed in the sample.

Keywords: Geikielite, electrical resistivity, high pressures, high temperatures, nano-materials