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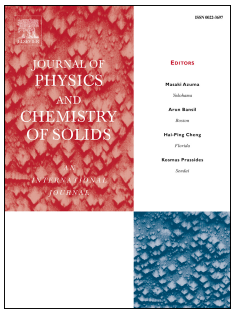

Influence of Jahn-Teller active Mn^{3+} ions on electrical and dielectric properties, thermopower and Mössbauer spectra of rutile-type $Fe_{1-x}Mn_xNbTiO_6$ ($0 \le x \le 0.9$)

A. Günther, R. Hochleitner, E. Schmidbauer, A. Schöttler-Himmel, M. Volk

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Influence of Jahn-Teller active Mn^{3+} ions on electrical and dielectric properties, thermopower and Mössbauer spectra of rutile-type $Fe_{1-x}Mn_xNbTiO_6$ ($0 \leq x \leq 0.9$)

A.Günther[a], R. Hochleitner[b] , E. Schmidbauer[c], A. Schöttler-Himmel[a], M. Volk[c]

[a] Department für Geo- und Umweltwissenschaften, Mineralogie, Petrologie und Geochemie, Universität München, Theresienstr 41, 80333 München, Germany

[b] Mineralogische Staatssammlung, Theresienstr 41, 80333 München, Germany

[c] Department für Geo- und Umweltwissenschaften, Geophysik, Universität München, Theresienstr 41, 80333 München, Germany

Abstract

Various electrical and dielectric properties were measured on rutile-type compositions $Fe_{1-x}Mn_xNbTiO_6$ ($0 \leq x \leq 0.9$) between ≈ 100 K and 750 K using impedance spectroscopy. DC conductivity σ_{DC} shows Arrhenius behavior for the bulk above room temperature (RT) for all x values. Starting from x = 0, there is a considerable change in activation energy E_A and σ_{DC}(300 K) between x = 0.1 and 0.2 with increase from E_A ≈ 0.3 to 0.6 eV, accompanied by a fall in σ_{DC}(300 K) from ≈ 10^{-4} to 10^{-8} $\Omega^{-1}cm^{-1}$; for x > 0.2 no considerable further variation with rising x is established. For x ≤ 0.1, below RT Mott's variable range hopping $T^{-1/4}$ law is obeyed for σ_{DC}. The known relaxor-type behavior of the dielectric constant ε' for x = 0 with very high peaks at 500-600 K for low frequencies (163 Hz-6 kHz) changes with rising x to consecutively lower values in ε' with disappearance of the peaks and with the largest values at the highest applied temperatures; the relaxor-type behavior can originate from a combination of bulk, grain boundary and sample-electrode effects. Below RT, a dramatic decrease in ε' is noted for low x values, resulting finally at ≈ 100 K for compositions of any x in the bulk value of ε' < 15. The thermopower above RT is negative, hence n-type conduction occurs and charge transport is attributed to small polaron hopping. ^{57}Fe Mössbauer parameters exhibit some irregularities between x = 0.05 and 0.2, ascribed predominantly to the influence of local distortions by Jahn-Teller active Mn^{3+} ions.

Keywords

A. Relaxor ferroelectrics

C. Mössbauer spectroscopy

D. Impedance spectroscopy

D. Electrical conductivity

D. Dielectric capacitance