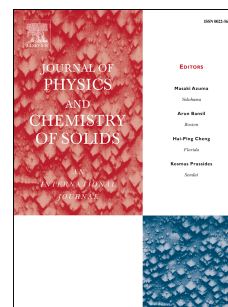


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# Influence of Jahn-Teller active $Mn^{3+}$ ions on electrical and dielectric properties, thermopower and Mössbauer spectra of rutile-type $Fe_{1-x}Mn_xNbTiO_6$ ( $0 \leq x \leq 0.9$ )

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## 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  $\approx 100$  K and 750 K using impedance spectroscopy. DC conductivity  $\sigma_{DC}$  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  $\sigma_{DC}(300\text{ K})$  between  $x = 0.1$  and  $0.2$  with increase from  $E_A \approx 0.3$  to  $0.6$  eV, accompanied by a fall in  $\sigma_{DC}(300\text{ K})$  from  $\approx 10^{-4}$  to  $10^{-8} \Omega^{-1}cm^{-1}$ ; for  $x > 0.2$  no considerable further variation with rising  $x$  is established. For  $x \leq 0.1$ , below RT Mott's variable range hopping  $T^{-1/4}$  law is obeyed for  $\sigma_{DC}$ . The known relaxor-type behavior of the dielectric constant  $\epsilon'$  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  $\epsilon'$  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  $\epsilon'$  is noted for low  $x$  values, resulting finally at  $\approx 100$  K for compositions of any  $x$  in the bulk value of  $\epsilon' < 15$ . 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

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