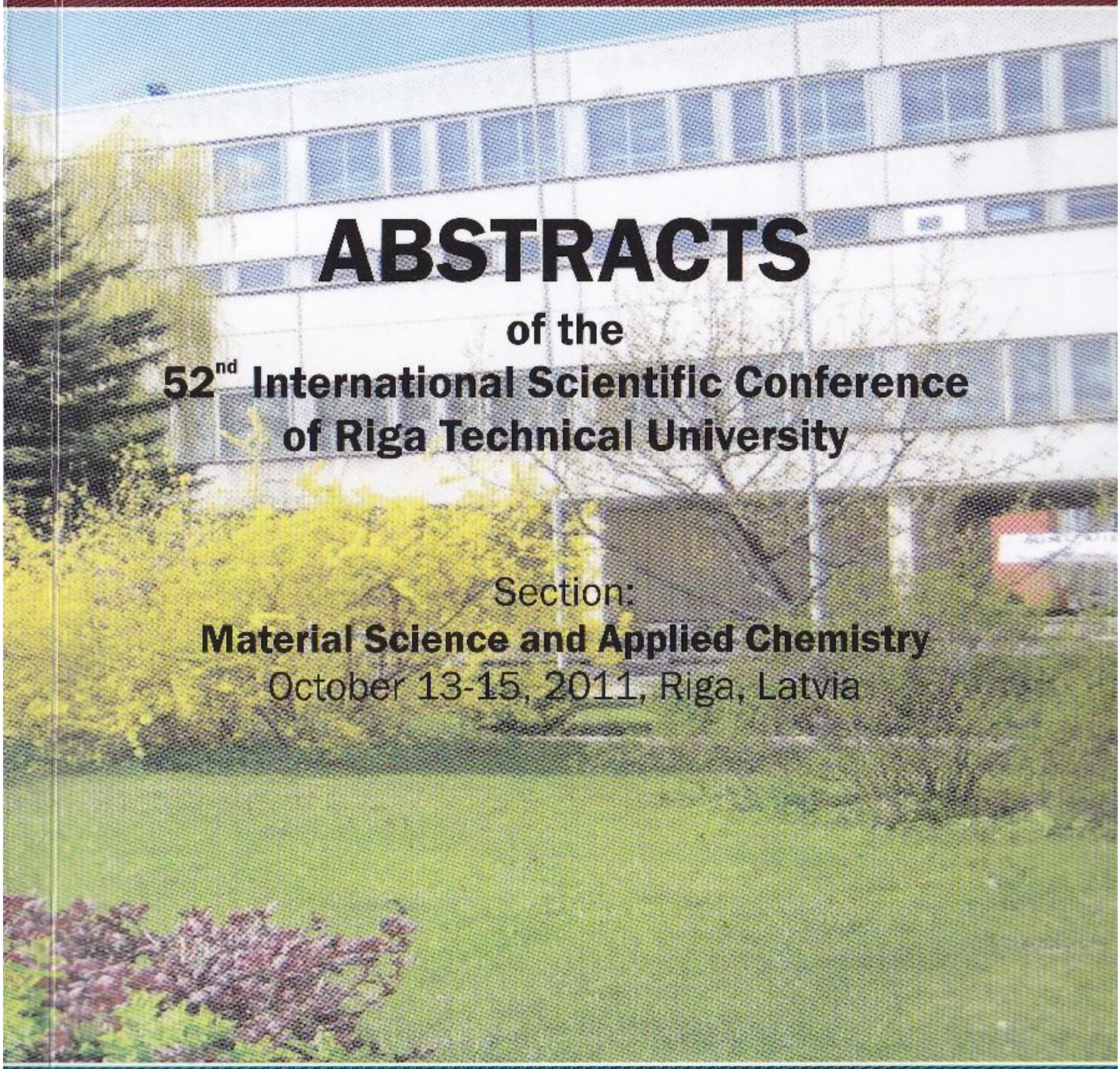
Riga Technical University
Faculty of Material Science and Applied Chemistry



ABSTRACTS

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Study of Impedance Properties of Non-Stoichiometric Ni-Zn Ferrite Annealed at Different Temperatures

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The work reports annealing temperature effect on $Ni_{0.3}Zn_{0.7}Fe_{2.1}O_{4-\delta}$ ferrite synthesized using auto-combustion method.

Impedance spectroscopy is an important tool to study microstructural effect on ferrite electrical properties and gives information about the resistive (real part) and reactive (imaginary part) components of the material. The overall resistance of the material is given by the combination of the grain interior and grain boundary resistances which can be seperated by using impedance spectriscopy.

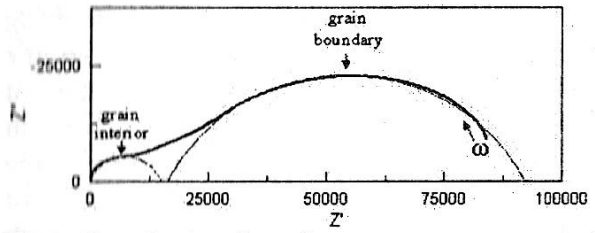

Fig.1 Complex impedance response of $Ni_{0.3}Zn_{0.7}Fe_{2.1}O_{4-\delta}$ ferrite annealed at 1200 °C

Generally, two semicircles are observed in the complex impedance plots (Fig.1) due to two different conduction and polarisation processes in the material. It is known that peak frequency (ω) for grain boundaries is much smaller than that for grains due to their large resistance. Due to this reason we attribute the higher frequency response (small arc) to the grains and the lower one (big arc) to the grain boundaries (see Fig.1).

The experimentally obtained impedance parameters are shown in Table 1. The values of grain boundary resistances (R_{gb}) are found to be higher than resistances of the grain (R_g), as well as resistances decreases by increasing annealing temperature. The higher value of R_{gb} could be due to higher porosity and concentration of imperfections in grain boundary volume. Annealing temperature effect on resistance can be attributed to volatilization of Zn ions and formation of Fe^{2+} giving arise for electron hopping between Fe^{2+} and Fe^{3+} ions as well as due to incomplete sintering – material contains narrow contacting necks between grains.

The values of capacitance (C) increases by increasing annealing temperature which means that samples annealed at higher temperature have greater polarizability due to higher Fe^{2+} ion content. Also sufficiently large differences in the time constants (τ) between grains and grain boundaries were observed.

Table 1

Impedance experimental parameters for $Ni_{0.3}Zn_{0.7}Fe_{2.1}O_{4-\delta}$ ferrite annealed at different temperatures

Annealing temperature °C	R_g (Ω)	C_g (F)	τ_g (s)	R_{gb} (Ω)	C_{gb} (F)	τ_{gb} (s)
900	$8.50\cdot10^{6}$	$1.11\cdot10^{-12}$	$9.41\cdot10^{-6}$	$2.76\cdot10^{7}$	$6.44\cdot10^{-12}$	$1.78\cdot10^{-4}$
1000	$2.76\cdot10^{6}$	$3.43\cdot10^{-12}$	$9.44\cdot10^{-6}$	$4.93\cdot10^{6}$	$9.45\cdot10^{-12}$	$4.66\cdot10^{-5}$
1100	$1.45\cdot10^{5}$	$7.28\cdot10^{-12}$	$1.05\cdot10^{-6}$	$1.64\cdot10^{5}$	$8.58\cdot10^{-11}$	$1.41\cdot10^{-5}$
1200	$1.60\cdot10^{4}$	$1.08\cdot10^{-11}$	$1.72\cdot10^{-7}$	$8.45\cdot10^{4}$	$1.09\cdot10^{-9}$	$9.22\cdot10^{-5}$
1300	$3.05\cdot10^{3}$	$1.55\cdot10^{-10}$	$4.74\cdot10^{-7}$	$1.88\cdot10^{4}$	$6.37\cdot10^{-9}$	$1.20\cdot10^{-4}$