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Characterization of nano sized Ni-Zn ferrite

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Summary
Sol-gel auto-combustion method was used to prepare fine $Ni_{0,3}Zn_{0,7}Fe_2O_4$ ferrite nanoparticles. The Ni-Zn ferrite has been calcinated at different temperatures from 900 °C to 1300 °C with step 100 °C. Effects of sintering conditions on structure of Ni-Zn ferrite has been studied with Fourier transform infrared spectroscopy (FTIR) but particle nano-sizes were verified by atomic force microscopy (AFM). For all samples the FTIR spectra show two fundamental absorption bands, which are inherent to inherent vibrations of tetrahedral and octahedral groups. Determined particle sizes for all compositions were in nanometer range.

Introduction
Ni-Zn ferrite is a one of the most versatile technological materials due to high resistivity and low-eddy current losses. It can be used in transformer cores, radio frequency circuits, red/write heads, and rod antennas [1].
The structural properties as cation distribution, behavior of localized electric charge carriers and microstructure properties as grain sizes and grain to grain boundary ratio is strongly dependent on preparation method and mechanical/thermal treatment, as well as particle size. Above mentioned parameters affects ferrite electric, magnetic and dielectric properties [2].
For ferrite preparation we used sol-gel auto-combustion method described elsewhere [3]. For structural studies we used FTIR spectroscopy what is an important tool for characterizing nano sized ferrite powder particles.

Results and discussion
Non-contact AFM image of Ni-Zn ferrite calcinated at 1300 °C is shown at Fig. 1. Average particle sizes can see in Table 1. Average particle size of all compounds is located at nanometer range. The largest average particle size is determined for Ni-Zn ferrite powders annealed at 1300 °C.

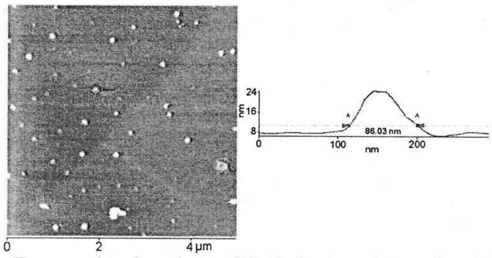

Fig. 1. Topographical analysis of Ni-Zn ferrite calcinated at 1300 °C.

The infrared absorption spectra of Ni-Zn are recorded in the range from 400 cm^{-1} up to 1600 cm^{-1}, because the infrared absorption regions of ions in the crystal lattice of solids are mainly located between 100 and 1000 cm^{-1} [4]. From obtained results we can observe typical spinel ferrite absorption bands which mostly are located in the range between 600 – 545 cm^{-1} and 430 – 400 cm^{-1} and are assigned to vibrations of tetrahedral (V_1) and octahedral (V_2) complexes [5]. Vibration bands owned for impurities were not observed. In the Ni-Zn ferrite tetrahedral site is occupied by Zn^{2+} and Fe^{3+} ions, but octahedral site is occupied by Ni^{2+} and Fe^{3+}. In case of Ni-Zn ferrite V_1 and V_2 values (Table 1) decreases by increasing calcination temperature. That can be attributed to increase of crystallite size. For nanoparticles insignificant changes in the environment of a chemical group will lead to deviation of vibration frequency bands [6]. Another reason for absorption bands deviation is Fe^{3+} ion replacement by bigger Fe^{2+} ion with higher atomic weight as a result of zinc volatilization [7]. Vibrations in the range from 1600 cm^{-1} to 1000 cm^{-1} were attributed to stretching vibrations of carboxylate groups and moisture absorbed on particles surface [7].

Table 1. Infrared properties and average particle sizes of Ni-Zn ferrite.

Calcination temperature, °C	900	1000	1100	1200	1300
V_1, cm^{-1}	565	564	564	558	555
V_2, cm^{-1}	422	421	420	418	416
D, nm	37	-	40	-	74

Conclusion

The Ni-Zn ferrite was successfully synthesized by sol-gel auto combustion method. The FTIR absorption spectra shows the presence of two adsorption bands which confirms the presence of two sublattice states. The AFM results show, that all obtained compositions were in nanometer range.

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