

# Effect of Ruthenium Substitution on the Structure and Magnetic Parameters of NiZn Spinel Ferrites

Mariana Ušáková<sup>1, a)</sup>, Elemír Ušák<sup>1</sup>, Martin Šoka<sup>1</sup>, Valerija Hodolič<sup>1</sup>,  
and Ján Lokaj<sup>2</sup>

<sup>1</sup>*Slovak University of Technology, FEEIT, Ilkovičova 3, 84104, Bratislava, Slovak Republic.*

<sup>2</sup>*Slovak University of Technology, FCFT, Radlinského 9, 81237, Bratislava, Slovak Republic.*

*<sup>a)</sup> Corresponding author: mariana.usakova@stuba.sk*

**Abstract.** The presented contribution is aimed at magnetically soft ferrite materials and the possibilities of influencing the magnetic behavior of these materials. NiZn ferrites with chemical composition  $(\text{Ni}_{0.42}\text{Zn}_{0.58})_{1-x}\text{Ru}_x\text{Fe}_{2-2x}\text{O}_4$  was synthesized by ceramic technology based on a solid-state reaction at sintering temperature of 1200 °C. The influence of the ruthenium content on the microstructure, morphology and chemical composition was monitored by means of scanning electron microscopy (SEM) with energy-dispersive X-ray spectroscopy (EDX). Microstructural and quantitative analysis of the elements confirmed the successful incorporation of  $\text{Ru}^{4+}$  ions into the spinel lattice of ferrite. During the substitution of NiZn ferrite samples, the increasing ruthenium content was manifested by a decrease in the iron concentration, with the increasing degree of substitution  $x$ , which has inverse character. Increasing ruthenium content also affected the magnetic properties of ferrite materials; the values of the Curie temperature as well as the magnetic susceptibility decreased due to the redistribution of cations between the tetrahedral A and octahedral B sublattice, which also affects the super-exchange interactions within the A-B sublattice. This effect was also evident on the course of the hysteresis loops and the parameters obtained from them; Mostly a monotonic, sometimes nearly linear relationship between the doping level (characterized by  $x$ ) and the particular magnetic parameters was observed.