Dielectric properties of composites formed by hydroxyapatite and niobium pentoxide

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ABSTRACT

Composite materials based on hydroxyapatite [HAp, $Ca_{10}(PO_4)_6(OH)_2$] and niobium pentoxide [PNb, Nb_2O_5] need to be studied due to their biomaterial characteristics and the importance of their dielectric properties. Hydroxyapatite (HAp) is an inorganic phosphate that has chemical and structural similarity to vertebrate bones and teeth, while niobium is an inert metal widely used in metallic alloys [1, 2]. The hydroxyapatite (HAp) used in this work was produced by calcining tilapia fish bones (oreochromis niloticus) according to the procedures contained in the letter patent no. PI 0506242-0 [3]. Niobium pentoxide, in powder form, was supplied by the Companhia Brasileira de Minas e Mineração (CBMM), with a purity content of 99.5%, which was thermally treated at 1100 ◦C and its structural characterization resulted in obtaining the H-Nb_2O_5 monoclinic phase [2]. In this work, some dielectric properties of the composite and precursors will be tested in the temperature range between 120–400 K and frequency 100 Hz–1 MHz, using impedance spectroscopy in order to obtain a detailed analysis of the electrical properties of the polycrystalline sample, as well as dielectric relaxation processes and resistive and conductive behavior, as it allows us to separate the real and imaginary components of the electrical parameters, providing us with a true picture of the material properties. Complex impedance spectroscopy is a technique used to study and analyze the microstructural and electrical properties of polycrystalline oxide systems, as well as of various materials, as it presents a better adaptation for the studies proposed in this work than other techniques, in addition to being a simple technique, cheap, safe and non-invasive method [4, 5, 6]. The treated material was characterized by Dynamic Light Scattering (DLS) and its morphology by scanning electron microscopy (SEM). X-ray diffraction (XRD) and Rietveld refinement detected the presence of the crystalline phase and good agreement was observed between experimental and calculated results, concluding that these materials are excellent for use both in dentistry and in orthopedic medicine.

Keywords: hydroxyapatite, niobium pentoxide, X-ray diffraction, impedance spectroscopy, DLS, SEM, biomaterials, powder metallurgy.

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