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Influence of particle size on electrical properties of Nanofluids oxide niobates

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Abstract – Nanofluids are heterogeneous mixtures of biphasic type compost for a continuous phase and a dispersed phase with size less than 100 nm. These materials have many industrial applications, such as paints, ceramics, cosmetics, pharmaceutical and agrochemical compounds. This work investigated the electrical properties by impedance spectroscopy of the nanofluido with 1% weight of nanoparticles ($KSr_2Nb_5O_{15}$) suspended in butoxyethanol. The electrical parameters resistance, capacitance and relaxation frequency were obtained and discussed.

The structure type tetragonal tungsten bronze (TTB) is a structure derived from perovskite classic, in which the structure of the octahedron BO_6 is transformed to give rise to three different types of places: tunnels pentagon and tetrahedral, similar to those found in the perovskite structure, which are favorable to substitution by cations and tunnels trigonals, friendly replacement for small cations and anions [1]. The TTB structure can be described by the chemical formula $A'_2B'_4C'_4Nb_{10}O_{30}$, where A', B' and C' denote different sites in the structure.

The ferroelectric phase ceramic oxide niobato potassium and strontium $KSr_2Nb_5O_{15}$ (KSN) was synthesized by modified polyol method (MPM) from the initial reagents: strontium nitrate $Sr(NO_3)_2$, potassium nitrate KNO_3 and salt complex niobium $NH_4H_2[NbO(C_2O_4)_3].3H_2O$. The temperature of calcination was done between 500°C and 1000°C with an interval of 100°C. . For X-ray diffraction (XRD) was determined the average size of crystallites (T_c) of the samples as listed in Table 1. The nanofluids of KSN were prepared using 2-butoxyethanol (BTXOL), brand Fluka, with purity more than 98% as a continuous phase for the nanoparticles of KSN. It was used 1% weight of nanoparticles suspended in BTXOL and the mixture was homogenized by ultrasound for 1 minute. The electrical characterization of samples was performed by using impedance spectroscopy in a sample holder type coaxial capacitor coupled in an impedance analyzer Novocontrol model of α-analysis. The range of frequency measures were between 5 Hz and 3 MHz with an applied potential of 500 mV at 27°C and relative humidity controlled at 46%.

Table 1 lists the physical parameters: size of crystallites (T_C), resistance (R), capacitance (C) and relaxation frequency (f_0) of nanofluidos investigated. Figure 1 show the impedance diagrams of the nanofluids of KSN without lowering indicating a Debye relaxation process and can be modeled by equivalent electrical circuit of the type RC in parallel based on only one electroactive component in the form of semicircle with physical parameters listed in Table 1. Generally, an increase in the resistance and capacitance and, a decrease in the frequency of relaxation of the nanofluids investigated, in relation to increased average size of crystallites, possibly is associated with reduced density of defects and increased crystallinity of nanoparticles

Samples	T_C (nm)	R (kΩ)	C (pF)	f_0 (kHz)
KSN_{500}	2,0	24,54	105,0	61,77
KSN_{600}	11	32,35	106.9	46,15
KSN_{700}	22	37,95	106,5	39,38
KSN_{800}	26	42,70	109,7	33,98
KSN_{900}	30	40,94	111,4	34,90
KSN_{1000}	42	42,47	111,3	33,67

Tabela 1: Electrical parameters of nanoparticles and nanofluids.

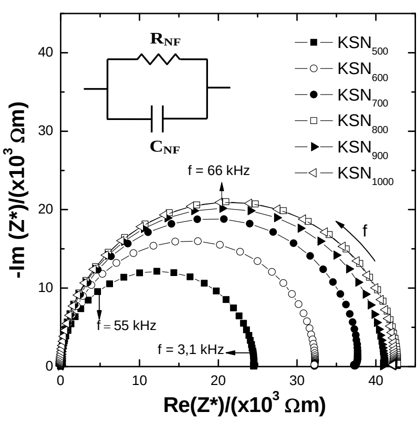

Figure 1: Diagram of impedance for nanofluids whit 1% suspended KSN in butoxyethanol.

[1] S. Lanfredi, L. R. Trindade, A. R. Barros, N. R. Feitosa and M. A. L. Nobre. Cerâmica 51, 318, 151-156, (2005).