Influence of TiO_2 addition on the $Mg_4Nb_5O_9$ ceramic phase and its application in the radiofrequency region

J. C. Sales[1,2*], F. A. C. Nobrega[1], J.P.C. Nascimento[2] A. J. M. Sales[2], W. V. S. Reis[2]. F. F. Carmo[2], R. F. Abreu[2], M.A.S. Silva[2], A. S. B. Sombra[2]

[1] State University of Vale do Acaraú, Center for Exact Sciences and Technology, Department of Civil Engineering, Brazil

[2] Telecommunication Engineering Department, Federal University of Ceará (UFC), P.O. Box 6007, Fortaleza, Ceará. 60755-640, Brazil.

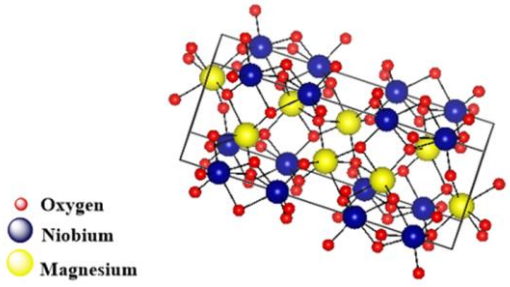
[*]e-mail: juscelinochaves@hotmail.com

The $Mg_4Nb_5O_9$ (MNO) ceramic matrix has optical and dielectric properties and can be used as an electronic optical device [1]. MNO also presents microwave properties in which it can form a composite with a high-quality factor, acting as a dielectric resonator [2]. But currently they are looking to study devices to operate in radiofrequency, because these devices can operate in millimeter waves acting as insulating capacitors or semiconductors.

And one of the candidates to act as these devices is MNO, which has a corundum structure [1,2], orthorhombic, as can be seen in Figure 1. Thus, in this work, a ceramic composite (1-x) $Mg_4Nb_5O_9$ – (x) TiO_2 by solid-state reaction at a temperature of 1150 °C for radiofrequency studies. By X-ray diffraction, the formation of MNO and TiO_2 phases was characterized and the non-formation of spurious phases, these samples also showed high values of relative density ranging from 88.57 to 91.90%.

The radiofrequency results demonstrate that these composites are thermally activated, as they show a decrease in activation energy from 1.59 to 1.37 eV with an increase in TiO2 concentration. Their Capacitance Temperature Coefficient values are close to zero in the 1 to 10 MHz frequency range. Thus, it is concluded that the composites (1-x) $Mg_4Nb_5O_9$ – (x) TiO_2 synthesized by the solid-state reaction may have potential application for radiofrequency devices since they have low activation energy and TCC values close to zero.

Figure 1 – Crystal structure of of $Mg_4Nb_5O_9$.



References

[1] K. Sarkar, V. Kumar, S. B. Das, M. Kumar, A. Manash, C. Biswas, S. Mukherjee, *Materials Today: Proceedings*, Volume 44 (2021), Pages 2459-2465. DOI: https://doi.org/10.1016/j.matpr.2020.12.524

[2] Y. C. Wu, H.T. Tseng, C. S. Hsi, J. Juuti, H.I. Hsiang.*Journal of the European Ceramic Society***,** Volume 42 (2022), Pages 448-452. DOI: https://doi.org/10.1016/j.jeurceramsoc.2021.10.059.