Tantalum-Based Ceramics for Microwave Applications

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Dielectric materials with a high permittivity (ε_r), a high quality factor (Q) and a low temperature coefficient of resonant frequency (τ_f) have become very important for the miniaturization of microwave devices such as filters or antennas [1]. Their properties are directly influenced by the cation ordering, grains size [2] and second phases formation. About 39% of the resonator materials are based on tantalates or niobates.

In this work, we have studied three different tantalum-based compositions: $Ba(Mg_{1/3}Ta_{2/3})O_3$, $Ba(Zn_{1/3}Ta_{2/3})O_3$ and $Ba(Y_{1/2}Ta_{1/2})O_3$. The ceramic bodies were obtained via a modified Pechini method [3] or by the solid-state reaction method. The influence of 0.50 % (gr.) Nb_2O_5 as sintering aid has been investigated.

The Pechini powders, as well as the final ceramics were compositional, structural and morphological characterized by thermal analysis, infrared spectroscopy, X-ray diffraction, scanning electron microscopy and transmission electron microscopy. The dielectric properties of the ceramic bodies were measured in the microwave range.

Pechini powders are nanosized and show cubic structure. In the case of $Ba(Mg_{1/3}Ta_{2/3})O_3$ and $Ba(Zn_{1/3}Ta_{2/3})O_3$, the sintering process makes possible the transition from a disordered cubic perovskite structure to a 1:2 ordered trigonal structure specific to this type of ceramics.

The prevention of zinc oxide volatilization and the achievement of relative good dielectric properties by processing the ceramics for short period of time at high temperatures represent the advantages of the Pechini method.

References

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