INFLUENCE OF SYNTHESIS TEMPERATURE AND SR SUBSTITUTION ON ABSORPTION CHARACTERISTICS OF BA SYSTEM MICROWAVE DIELECTRICS

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Abstract: *microwave dielectric materials are widely used as radar absorbers and chip materials as well as satellite communicators and portable telephones. The article discusses the influence of $Ba_{1-x}Sr_xTiO_3$ system on the microwave absorption characteristics in the 9 ~ 10GHz band. In the experiment was set the Sr substitution rate and carried out the X-ray structure analysis. Also examined absorption characteristics of materials according to synthesis temperature and investigated the microwave absorption characteristics according to content Sr of $Ba_{1-x}Sr_xTiO_3$ system.*
Keywords: *influence, temperature, Sr, Ba, microwave dielectrics.*

The material of microwave dielectrics is used widely to satellites, portable telephones, as well as radar absorption and screening materials.

In this paper the influence of $\mathrm{Ba_{1-x}Sr_xTiO_3}$ system on the microwave absorption characteristics in the 9 ~ 10GHz band was experimentally confirmed.

1. Experimental method

In the experiment, the Sr substitution rate of $\mathrm{Ba_{1-x}Sr_xTiO_3}$ system was set to

x = 0.1 ~ 0.4.

The basic materials were weighed to the stoichiometric ratio using $\mathrm{BaCO_3}$ (99%), $\mathrm{SrCO_3}$ (99.5 %) and $\mathrm{TiO_2}$ (99 %). The basis weight of the sample was 10^{-3}g of precision by using the electric balance "FX – 300" and the weighed sample was carried out to mixing and grinding with a wet ball mill for 30 h.

To evaluate the reasonable ratio of ball: sample: distilled water, the blending ratio according to mixing ratio was experimentally investigated. In general, it is common to making mixable ratio in volumetric: samples: distilled water = 1: 1: 0.6 ~ 0.8 in the dielectric ceramics making process, when the mixing ratio is 1: 1: 1 ~ 1: 1: 1: 2, the mix – milling ratio was increased.

Then, the rotational frequency of ball – mill was 130 – 160 r/ min by the diameter of the ball-column.

The mixed and pulverized samples were dried at a temperature of 100 °C for 24 hours until they became constant weight, pulverized with a mortar, sieving of 100 µm sieve, then was poured into the column the 7 wt % distilled water, and was formed into same sieve again. After were synthesized and put into alumina crucible the composite sample of size $_{\varphi}$ = 40 mm on the pressure of 50 MPa.

Synthesizing increase to final synthesis temperature on the speed v = 100 ˚C/ h and carried out to method keeping it. Synthesis conditions were maintained between 900 – 1200 °C for 3h and cooling naturally. The composite sample was milled again into ball – mill, sieving, and made the specimens with a thickness of 2 mm.

2. Results and discussion

First, the X-ray structure analysis of the $\mathrm{Ba_{1-x}Sr_xTiO_3}$ system (x = 0.27) carried out. X-ray diffraction analysis (XRD – Rigaku) was carried out at 2θ = 18 – 60 ° using CuKα and Ni filter.

The X-ray diffractive graphic shows that this system has a tetragonal structure at room temperature and that the $\mathrm{Ba_{1-x}Sr_xTiO_3}$ phase was precisely formed at 1100 °C.

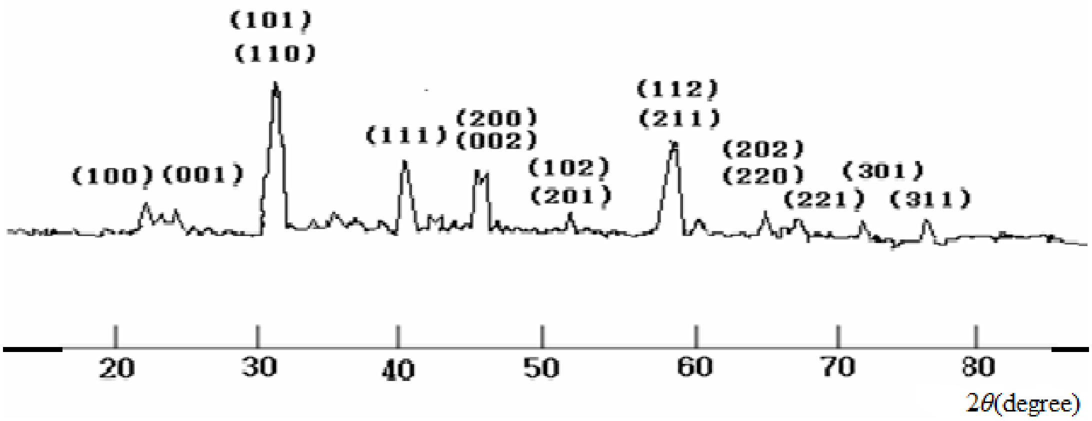

Fig. 1. X-ray diffractive graphic of $Ba_{0.73}Sr_{0.27}TiO_3$

According to the literature [1, 2, 3], the BT material is formed with solid solution at more than 1200°C and has a tetragonal structure, but solid solution material is formed at 1100°C in the experiment. This is because the sintering property of the material is improved due to the effect of Sr, which is a substitute.

In the experiment, first, absorption characteristics of materials according to synthesis temperature were examined.

Figure 2 shows the standing wave number change of the $Ba_{1-x}Sr_xTiO_3$ (x = 0.27) material at 9.4 GHz according to the synthesis temperature. As see in figure, the standing wave coefficient is minimized at around 1100°C, where the BST dielectric material is fully formed. This shows that the temperature at which the BST solid solution is completely formed is near 1100°C, and the microwave absorption characteristic of the material is increased.

Secondly, the microwave absorption characteristics according to content Sr of $Ba_{1-x}Sr_xTiO_3$ system were investigated. Characteristic measurements were carried out at 9.4 GHz for Φ = 40 × 2 mm specimens.

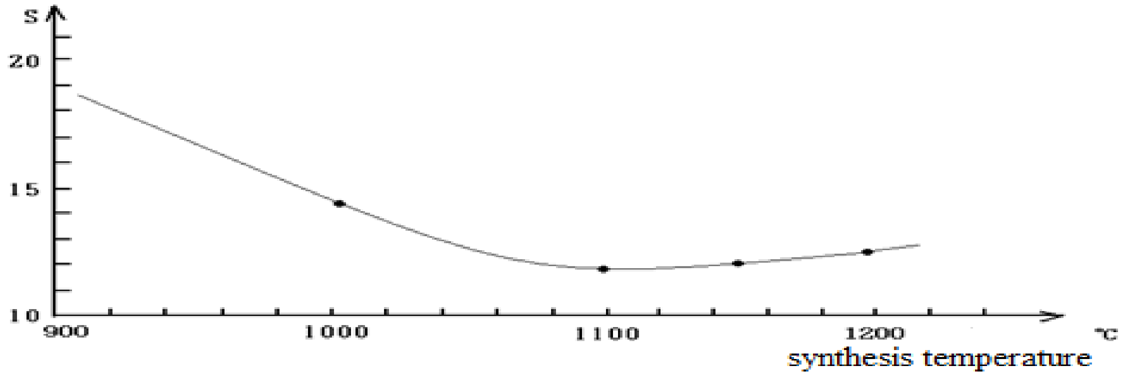

Fig. 2. The steady-state logarithmic change according to the synthesis temperature of $Ba_{1-x}Sr_xTiO_3$ (x = 0.27)

The change of the standing wave coefficient S according to the content of Sr is shown in figure 3.

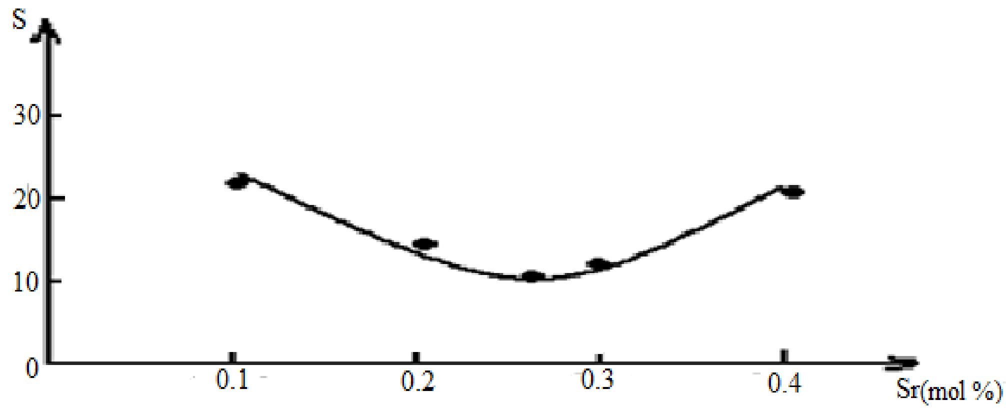

Fig. 3. Change of the standing wave coefficient S according to the content of Sr

As shown in the figure, the standing wave coefficient decreases to 0.27 mol % depending on the amount of Sr and increases above that.

The change of the standing wave coefficient S depending on the amount of Sr can be considered to be caused by the ion radius difference of the substituted atoms. Because of the ion radius of Sr^{2+} is 0.144 nm, and of Ba^{2+} is 0.161 nm, when the proper amount is entered, this can considerate which the lattice deformation is caused to increase the loss. Therefore the BST has a dielectric constant of 45 and a standing wave coefficient s = 12 when the contents of substituted Sr is 0.27 mol %, and has a reflection loss of about 1.4 dB.

Conclusion

1) It was found that the proper plastic conditions of the BST system affecting the microwave absorption characteristics are 1100°C and 3 h.

2) The optimal replacement amount of Sr, which affects the enhancement of the absorption characteristics of the BST system, is 0.27 mol %, and the dielectric constant is 45 and the standing wave coefficient is s = 12 at 9 to 10 GHz.

References

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