Microstructural evolution of Ni-Cu-Zn Ferrites during low temperature sintering

J. Töpfer, J. Mürbe,

Fachhochschule Jena, FB Werkstofftechnik, C.-Zeiss-Promenade 2, 07745 Jena, Germany,

Ni-Cu-Zn ferrites are key materials for inductive components in thick film multi-layer structures. In the low temperature ceramic cofiring process (LTCC) sintering is performed at 900°C; therefore ferrites with large sinter activity are required. The composition of the ferrite of the system $(Cu_yNi_{1-x-y}Zn_x)_{1-z}Fe_{2-z}O_4$ with $0.2 \leq y \leq 0.25$ strongly affects the sintering behavior; some Fe-deficiency z is required to enhance densification at T < 900°C.

Powder morphology is shown to be an important issue for the fabrication of multi-layer devices. Sub-micron powders obtained by attrition milling show enhanced sintering activity and result in high densities of toroids after sintering at 900°C: ferrite powders with a mean particle size of 0.5µm give dense bodies with a density of 96% at 900°C.

The role of Bi_2O_3 as sintering aid was studied: the density increases up to 99% for samples sintered at 900°C. Dilatometric studies show that a different sinter mechanism is valid compared to Bi-free samples. The temperature of maximum shrinkage rate is reduced down to 850°C by Bi-addition. The microstructure undergoes dramatic changes if the bismuth oxide concentration is varied between 0-1%. A fine-grained homogeneous microstructure is obtained for 0-0.25% Bi_2O_3, while for >0.5% a large-grained structure is observed. For intermediate Bi_2O_3 concentrations an inhomogeneous duplex structure occurs.

The permeability increases for small bismuth doping, but is reduced for a Bi_2O_3-content of more than 0.5%. Maximum permeability of μ_i = 900 is observed for intermediate Bi doping. The correlations between the permeability and ferrite microstructure will be discussed.