

New ferrimagnetic garnets for LTCC-technology circulators

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Yttrium Iron Garnet based ferrites are used in non-reciprocal devices like microwave circulators and isolators [1]. The low dielectric and magnetic losses of those materials provide the required properties. The main drawbacks of circulators are their size and cost, due to complex mechanical assembling of the different materials.

In order to simplify this complex assembling, a possible solution would be to adapt the different materials to a common LTCC (Low Temperature Cofired Ceramics) process: the circulators would be produced with a multilayer process [2][3]. We showed that cationic substitutions (bismuth and copper) enable a considerable decrease in the sintering temperature of garnets, from about 1450°C to about 950°C. Due to bismuth content, a high permittivity is achieved allowing the reduction of the circulator size. Our most recent results show that it is possible to decrease this temperature down to 880°C, thanks to vanadium substitutions. This significant decrease of sintering temperature leads to a compatible material for cofiring with gold serigraphy ink and in particular with silver ink (melting point of 1064 and 962°C respectively). Different assemblies of tapes were studied: ferrite with silver or gold, ferrite with dielectric and ferrite with dielectric and metallization.

Material analyses are exposed (dilatometry, coefficient of thermal expansion...) and the main magnetic and dielectric properties are discussed (permittivity and saturation magnetization). Moreover the first results of circulators in LTCC-technology with gold and silver serigraphy are presented (transmission, isolation and return loss) and the compatibility of the different elements is analyzed.

[1] Harris V. (2012). Modern Microwave Ferrites. IEEE Transaction on Magnetism, vol. 48, no. 3, 1075-1104. 10.1109/TMAG.2011.2180732

[2] Jensen T., Krozer V. and Kjaegaard C. (Janv. 2011). Realisation of microstrip junction circulator using LTCC technology. Electronic Letters, vol. 47, no. 2. 10.1049/el.2010.2419

[3] Yang S., Vincent D., Bray J. and Roy L. (Oct. 2014). Ferrite LTCC edge-guided circulator. Proceedings of the 9th European Microwave Integrated Circuits Conference, 596-599. 10.1109/EuMIC.2014.6997927