

Radio Frequency characterization of LTCC materials in K and W Bands

Khodor RIDA, Camilla KÄRNFELT, Alain PEDEN, Jean-Philippe COUPEZ, Guy CHUITON, Pascal COANT.

Lab-STICC, Telecom Bretagne, Technopôle Brest-Iroise - CS 83818 - 29238 Brest Cedex 3 – France.

Email: khodor.rida@telecom-bretagne.eu

Telecommunication and automotive industry requires high volume and low cost circuit fabrication, while at the same time demanding excellent electrical performance, reliability, circuit miniaturization and surface mounting techniques. Today, the multilayer LTCC (Low Temperature Co-fired Ceramics) technology is getting more attention for millimetre wave applications, and is often chosen because of its high degree of integration and its high-reliability properties. This technology is being installed in our laboratory at Telecom Bretagne and the commercial ESL41110 tape was selected to make our first RF LTCC circuits. This tape was characterized at ESL (Electro Science Laboratory) from 3 to 19 GHz, and the substrate properties such as dielectric constant and insertion loss are given in [1].

As this material has not previously been characterized up to millimetre wave frequencies, this paper presents the extraction of the electrical properties of the ESL41110 material in both K and W bands. Several methods on the RF characterization exist; in this paper we use two different techniques. At K band frequencies, we use resonating structures employing ring [2], [3] and T-junction resonators, while at W band frequencies, we use the free space (or quasi optical) method [4].

The design and fabrication process of test samples is presented in section I, we note that the gold ink also issued by ESL (ESL803 [5]) is used as conductor metallization in our LTCC system.

The second section describes the material characterization by two-port microstrip resonators (ring and T-junction resonators) up to 26 GHz; the dielectric properties parameters are then extracted from the measured S-parameters.

The third section in this paper describes the free space method; Broadband measurement results from 75 to 110 GHz are obtained by using the quasi optical bench. The extracted real part of the complex permittivity is found to be about 4.2 and the $\tan \delta$ is about 0.018 in the 75 – 82 GHz band.



Fig.1 – Microstrip resonators on ESL41110 substrate.

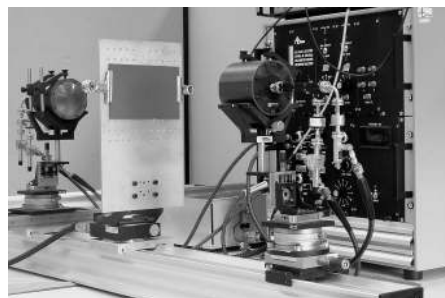


Fig.2 – Test bench in the W -band composed of two Gaussian beam horn antennas [4].

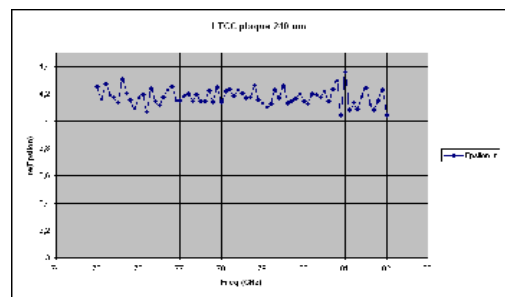


Fig.3 – Extracted real part of the complex permittivity from 75 to 82 GHz.

[1] ESL site web: <http://www.electroscience.com/pdf/41110.pdf>.

[2] R. Kulke, W. Simon, A. Lauer, M. Rittweger, P. Waldow, S. Stringfellow, R. Powell, M. Harrison, J-P. Bertinet, "Investigation of Ring Resonators on Multilayer LTCC," *MTT-S Int. Microwave Symp, Workshop on Ceramic Interconnect Technologies*, Phoenix, AZ, May 2001

[3] P. A. Bernard and J. M. Gautray, "Measurement of Dielectric Constant using a Microstrip Ring Resonator" *IEEE Transactions on Microwave Theory and Techniques*, Vol. 39, No.3, March 1991.

[4] Bourreau D., Pédén A., Le Maguer S.: "A quasi-optical free-space measurement setup without time domain gating for material characterization in the W band", *IEEE Trans. Instrum. Meas.*, 2006, 55, (6), pp. 2022–2028.

[5] ESL site web: <http://www.electroscience.com/pdf/803.pdf>.