Simulation-based resonant material measurement technique for precise characterization of LTCC and ULTCC materials towards 5G applications

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SUMMARY

Dielectric resonator methods have been recognized by the scientific and industrial communities for their high accuracy of electromagnetic material characterization [1]. In the Split-Post Dielectric Resonator (SPDR) configuration they can be applied to characterization of laminar dielectrics and high-resistivity semiconductors, delivering complex permittivity and resistivity values. The unprecedented accuracy of the SPDR technique discussed in this work [2], as high as 0.3% for relative permittivity and 2% for loss tangent, is owed to rigorous electromagnetic modelling used to support dedicated calibration process, performed for each device unit.

In this work we discuss fundamentals of the SPDR method, design and modelling methodology with regards to its application to precise characterization of novel materials dedicated for emerging 5G and 6G electronics [4]. The focus is given to LTCC (low temperature co-fired ceramics) and novel ULTCC (ultra-low temperature co-fired ceramic) materials [5], which recently gain continuously growing interest due to their lowered, compared to high temperature co-fired ceramics, sintering temperature while keeping compatibility with already existing fabrication methods. The LTCC and ULTCC materials are foreseen to deliver enhanced manufacturing flexibility, miniaturization, and packaging degree next to lower production cost, higher sustainability and environmental friendliness. Their precise characterization with regards to complex permittivity, further used in the electromagnetic design of telecommunication components such as antennas, serves a crucial role for boosting application of LTCC and ULTCC materials in demanding 5G and 6G systems.

Our conference presentation will discuss and summarize modelling and measurements methodology applied to SPDR technique and their validation conducted by measurements of literature well-established reference samples, sapphire and fused silica. Furthermore, rigorously prepared LTCC and ULTCC material samples will be presented and results of their characterization conducted with the aid of SPDR test-fixtures, designed to operate at different microwave frequencies, will be evaluated and their applicability to 5G and 6G systems will be verified.

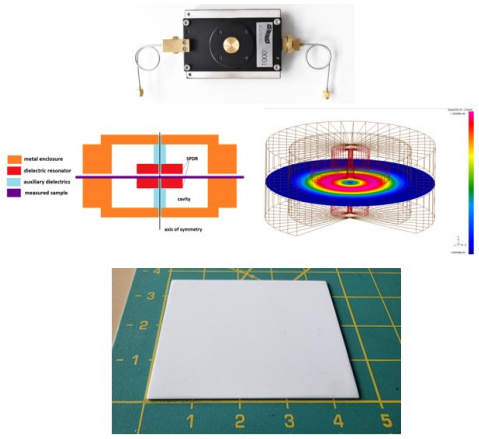

Fig. 1. SPDR test-fixture and its simulation model in FDTD QuickWave software [6] (a) and exemplary LTCC sample under test (b).

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