Contribution ID : **30** Type : **Oral presentation**

Measurements of Electromagnetic Properties of Low-loss Dielectrics in the mm-Wave and sub-THz Bands

Friday, 8 July 2022 09:20 (20)

Low-loss materials find multiple applications in the modern electronics industry with dielectric-based substrates used in printed circuit boards (PCB's) being a prominent example. Others include ceramic materials and plastics employed in packages for integrated circuits or supportive and protection structures for integrated antennas. There is a strong interest in efficient and easy-to-use methods to characterize all such materials at higher frequencies for dielectric constant (Dk) and dielectric loss (Df).

The main goal of this paper is to present a novel approach to material measurements at the mm-wave band based on high-Q Fabry-Perot resonators, which has been found efficient up to the frequency of 120 GHz. The upper limit is a result of available coaxial transmission lines employed to excite the resonator loaded with a sample under test and is expected to rise when new types of the lines (of smaller diameters) are offered.

In order to overcome this limitation we have attempted to combine the dedicated Fabry-Perot resonator with sub-THz spectrometers operating in either time- or frequency-domain. As a result, low-loss materials can be efficiently characterized in a ultra-broad frequency band extending from ca. 10 GHz up to hundreds of GHz employing, first, the mm-wave set-up based on a resonator and a vector network analyser (VNA) and, then, a sub-THz set-up with a spectrometer as a source of test signals. The effort will be divided into two tasks aimed at obtaining a set of numerical and mechanical models of structures with couplings, which provide as weak loss of cavity's Q-factor as possible.

The results in form of Dk and Df data on some dielectric materials measured up to the sub-THz bands will be presented.

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Session Classification : Fri 08/07 Morning 1 / Abstract ID