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Evaluation of Dielectric Measurements upon Thin Single Layer Solids using Open-Coaxial Probe Technology

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Measurements of the complex permittivity of materials as functions of frequency provide valuable information in different fields of engineering, industry, medicine and physical chemistry. Open-Ended Coaxial probes (OCP) are commonly used as nondestructive testing tools for dielectric analysis. The method, although nondestructive, does have limitations. For example, if there is an air gap between sample and probe, the discontinuity in the normal electric field causes a considerable error in the predicted permittivity. Even a small gap of the order 10 μm in thickness can produce large errors in permittivity measurement by sensors (10% or more) because it lies in the region where the fringing fields are most intense [1]. For this reason, usually the probe use has been limited to liquid and semiliquid measurements, where good contact can be obtained.

The work reported here has important consequences for improving coaxial sensor measurement upon thin layer homogeneous solids. In this study the National Institute of Advanced Industrial Science and Technology, (AIST Japan), and the Foundation for Research on Information Technologies in Society (IT'IS Switzerland) have entered into a joint interlaboratory comparison project to compare and improve methods of dielectric measurements of solids with reduced uncertainty. AIST has provided two Cyclic Olefin Polymer (COP) for dielectric characterization. At IT'IS Foundation measurements were performed from 4 MHz to 67 GHz using Dielectric Assessment Kit for Thin Layers (DAK-TL-P) from Schmid and Partner Engineering AG (SPEAG) which is based on OCP technology. To improve the sample-probe contact during solid material measurement, DAK-TL-P system is able to apply mechanical force up to 1000 N to avoid airgap formation between probe and the material under test. At AIST Dielectric analysis was performed using balanced-type circular-disk resonator method at five different frequencies: 16, 29, 42, 55 and 68 GHz.

The obtained results lie within the combined uncertainty of both methods with En factors below unity. In particular for low losses, the resonator method provides high precision at discrete frequencies.

1. A. P. Gregory, R. N. Clarke, T. E. Hodgetts, G. T. Symm, "RF and Microwave dielectric measurements upon layered materials using coaxial sensors" *NPL report*, 2008.