Dielectric Measurements of Brain Phantom and Standard Materials

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Open-probe dielectrometry, in which a flat-ended open coaxial line, with or without a ground plane, is immersed in a material whose dielectric properties are to be measured, has proven very useful in measurements of the dielectric properties of biomaterials. One advantage of this technique is that it is minimally perturbing of the sample being measured, which is very important for the measurement of *in vivo* or *in-vitro* tissue samples. The technique is also capable of good accuracy when appropriate calibration techniques are used, and can be used to make measurements of small quantities of material. For application over a wide frequency range, in our system to 26.5GHz, it is important to calibrate with materials that are similar in dielectric properties to an unknown sample. This is particularly true as the measurement frequency increases, because of radiation from the end of the open-ended coaxial probe. The technique has the capability to distinguish small differences in dielectric properties and can be used for compositional assessment of mixtures, for example alcohol/water mixtures (Jian-Zhong Bao, Mays L. Swicord, and Christopher C. Davis, J Chem. Phys. 104, 4441-4450, 1995.)

A recent important application of the technique is in the measurement of tissues in the mammalian head, which provides complex dielectric data for inclusion in exposure assessment of humans exposed to electromagnetic fields, especially those emitted by hand-held wireless phones. In addition the technique has proved valuable in the development and quality assurance of dielectric test liquids for use in “phantom” models used for wireless phone exposure assessment. In such measurements, various “phantoms” – models of an exposed object – are exposed to RF radiation and the spatial variation of SAR determined with scanned field and temperature probes. Typical phantoms are either flat slabs, or anthropometric models of the human head and torso, loaded with a brain simulant liquid. These phantoms are irradiated either with standard dipole antennas, or with real wireless phones, which allows an assessment of the likely human exposure that results with real phone use. In this paper various of these issues will be discussed, especially the reproducibility of the dielectric properties of brain simulant liquids, the dielectric properties of bone, and the difficulty in measuring this reliably in an *in-vivo* state.