Dielectric Properties of Low-loss Polymers for mmW and THz Applications

Seckin Sahin*, Niru K. Nahar and Kubilay Sertel
ElectroScience Laboratory, The Ohio State University
1330 Kinnear Rd, Columbus, OH 43212

Low-cost and high-performance substrate-integrated antennas for millimeter-wave (mmW) and terahertz (THz) band connectivity necessitate use of low-loss materials for fabrication and packaging. In addition to commonly-used semiconductor substrates, polymers are a viable option due of their availability and relatively low-loss performance. They have been widely used for RF applications as antenna canopies, radomes and as transmission line support materials such as coaxial and micro-coaxial lines. Nevertheless, electromagnetic properties of many polymers are not well-characterized in the mmW and THz bands. Particularly for on-chip antennas, accurate characterization of material loss is badly needed to incorporate suitable polymers in next-generation mmW and THz-frequency radiators.

In this work, we characterize several commonly-used polymers using a THz time-domain spectroscopy system. Namely, dielectric permittivity and loss tangent of thin layers of Polystyrene, SU-8, SUEX, Parylene-N and Polyimide were extracted in the 100GHz-2THz range using transmission magnitude and phase. Furthermore, lithographic processing effects (such as UV exposure) on material losses are also addressed for SUEX films for the first time. For an accurate extraction of the material properties, an analytical multilayered media transmission coefficient model is fitted to the measured data through iterative nonlinear least-square method. In addition, we develop a simple polynomial-based formula that allows for extrapolation of the measured permittivity and loss tangent over a much broader frequency range. Each polymer was characterized over 100 GHz- 2 THz range and the characterization results along with various applications of the tested polymers will be presented at the conference.