Characterization of SU-8 Using Terahertz Time-Domain Spectroscopy

Nima Ghalichechian[(1)]*, Jonathan P. Doane[(1)], Wonbin Hong[(2)], Kubilay Sertel[(1)], and John L. Volakis[(1)]
(1) Electroscience Laboratory, The Ohio State University, Columbus, OH, USA
(2) DMC Research Center, Samsung Electronics, Suwon, South Korea

Among available materials for millimeter wave applications, SU-8 is one of the best choices due to its low dielectric losses and fine resolutions of UV-lithographic processing techniques. Of importance is that SU-8 can allow the generation of thick material layers (on the order of 500μm), making SU-8 very attractive for monolithic integration of mmWave on-chip interconnects and large bandwidth antennas post-chip production.

SU-8 is commercially available in several forms, and can be processed with precise thicknesses and under various temperature conditions. However, the electromagnetic properties (permittivity and loss tangent) specified by the manufacturer are only provided at low frequencies. In the case of mmWave and sub-mmWave frequencies, accurate characterization of the permittivity and material loss is necessary prior to prototyping. The effects of processing on material losses is also important and has been considered by other authors for cured and uncured SU-8 samples (M. Naftaly and R. Miles, Proc. of IEEE, Vol. 95, 2007).

Here, we present the characterization of SU-8 samples using terahertz time-domain spectroscopy and transmittance data measured over the 200GHz-1THz band. The generalized transmission coefficient for the 430-μm-thick SU-8 layer is used to extract the frequency dependent complex permittivity $\varepsilon(\omega) = \varepsilon'(\omega) - j\varepsilon''(\omega)$ using a quadratic polynomial model. Measured data shows that the permittivity that is approximately ε_r=3.23 and ε_r =2.92 at 200GHz and 1THz, respectively. The loss tangent for SU-8 was found to be tanδ=0.027 (at 200GHz) and tanδ=0.055 (at 1THz). This data were also used to extrapolate the loss tangent down to 1GHz, giving tanδ=0.016, consistent with the manufacturers' specification. Such favorable levels of material losses should enable the design and fabrication of a wide range of mmWave and THz components, interconnects, and radiators.