Effect of conductor profile on the insertion loss, phase constant, and dispersion in thin high frequency transmission lines

Allen F. Horn III, Ph.D.
Associate Research Fellow
Lurie R&D Center
Rogers Corporation
Rogers, Connecticut USA

Abstract
It has been long known that conductor surface roughness can increase the conductor loss as frequency increases to the extent that the signal skin depth is comparable or smaller than the scale of the conductor roughness. In the present work, we experimentally show that the increase in conductor loss is larger than the factor of two predicted by the most widely used roughness factor correction correlations. This is consistent with the findings of a more recent theoretical paper on the effect of random roughness on conductor loss.

We also experimentally show that increasing the conductor roughness alone increases the phase constant or effective dielectric constant, in thin circuitry by up to 15% and substantially increases dispersion. Conductor profile is clearly a major variable in the performance of thin high frequency circuits.

A subtle adjustment to the conductor model in Sonnet Software related to the conductor roughness accounts quantitatively for both the insertion loss and phase constant effects.

Author's Biography
Allen F. Horn, III, Associate Research Fellow, received a BSChE from Syracuse University in 1979, and a Ph. D. in chemical engineering from M.I.T. in 1984. Prior to joining the Rogers Corporation Lurie R&D Center in 1987, he worked for Dow Corning and ARCO Chemical. At Rogers, Horn has worked on the development, processing, and testing of composite high frequency circuit substrates. He is an inventor/co-inventor on 15 issued US patents in the area of ceramic or mineral powder-filled polymer composites for electronic applications.