Appliqué Antennas Printed by Low Temperature Direct Write Processing Using a New Highly Conductive Ink

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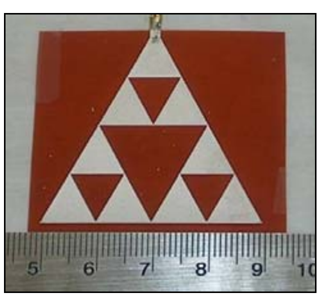
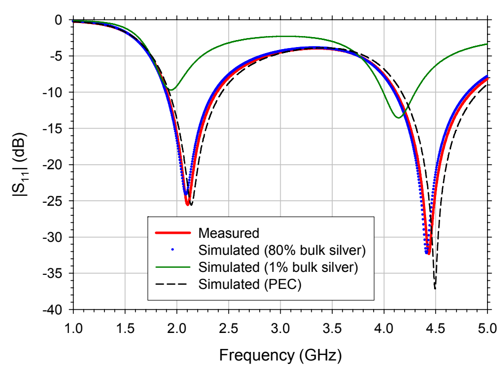
We demonstrate in this paper the capability of direct write processing to produce antennas on flexible, low temperature substrates. In turn, such antennas can be affixed to larger, and potentially curved and/or flexing, structures. In the sense that these flexible antennas can be attached externally and in a conformable manner, the term "appliqué antenna" seems appropriate.

Our antennas have been produced using the Maskless Mesoscale Material Deposition (M^3D^{TM}) process developed by Optomec, Inc. (www.optomec.com). We routinely attain feature sizes smaller than 25 μm using this additive, non-contact process without lithography, masks or resists. A key development that extends this process to microwave-frequency applications is our new silver "ink," which has a sufficiently large electrical conductivity σ to reduce Ohmic losses to acceptable levels. We routinely achieve 80-85% of bulk silver (where σ_{Ag}=6.2x10^7 S/m) after post-deposition heat treatment near 400ºC.

The antenna shown in Fig. 1(a) is a simple, yet instructive, example of an appliqué antenna we constructed by M^3D. The $|S_{11}|$ comparison in Fig. 1(b) between the measured and simulated data is very favorable. For simulation, we used 0.8xσ_{Ag} as the conductivity of the antenna and made a 1.25% reduction in the antenna dimensions to compensate for physical features of the feed region we could not adequately model. Also shown in Fig. 1(b) is the predicted $|S_{11}|$ response if the antenna had been manufactured from a conductor with $\sigma=\sigma_{Ag}/100$. It is apparent that such a low value, which is found in many silver nano-particle inks, has a marked degradation on the antenna performance. Conversely, it is apparent from Fig. 1(b) that there is a much smaller change in the performance at the feed if the antenna were made from a perfect conductor rather than our ink.



(a)



(b)

Fig. 1 (a) Sierpinski gasket antenna fabricated by M^3D using our silver ink on Kapton. The ruler units are cm. (b) Simulated and measured input $|S_{11}|$ of this antenna.

While it is not particularly difficult to construct this Sierpinski gasket antenna with M^3D, it does prove that flexible, highly-conductive antennas can be manufactured using direct write processing on low temperature substrates and that an excellent, direct electrical connection at the antenna feed is possible.