X-Band Conformal Antenna Fabrication Using Direct Digital Manufacturing

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Additive manufacturing (AM) is being used to fabricate electromagnetic devices with performance-enhancing structural features that are not possible or practical to cost effectively manufacture using conventional methods. For example, there have been many recent examples of innovative dielectric lens, waveguide resonator and waveguide horn antenna designs operating well into the sub-mm wave frequency range that demonstrate the versatility of AM techniques based on polymer extrusion, polymer jetting, Stereolithography and selective laser melting or sintering. The typical approach involves either a single material (dielectric or metal) or a sequential process combining polymer-based AM followed by plating, dipping or painting. This work is focused on advancing a hybrid direct digital manufacturing (DDM) approach that combines selective deposition of both polymers and conductors. Specifically, fused deposition modeling is used as the primary method for polymers and micro-dispensing for conductive pastes. Multi-layer circuits fabricated using the hybrid approach have been demonstrated in an S-band phased array antenna element and in single layer patch antennas up to V-band. In this work the focus is on design and 3D printing advances that enable high accuracy, direct deposition of multi-layer patch antennas on conformal surfaces operating in the X-band. The performance is on par with that achievable using PCB processing and low loss copper-clad laminates, with the advantage of arbitrary form factor and intrinsic structural integration.