3D Printed Liquid Metal Molds for Antenna and Feed Packaging

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Recent advances in additive manufacturing hold promise for new applications in radiofrequency (RF) electronics. In particular, 3D printing of antennas allows for new degrees of freedom that can improve bandwidth, efficiency, or pattern behavior. In principle, custom devices can also be printed quickly with minimal retooling cost. Most existing 3D printed antennas are based on the 3D printing of metals onto fixed substrates. However, additive manufacturing of metals has proven to be challenging because of the difficulty in formulating conductive inks that can print fine features on curved surfaces and retain desirable electrical. An alternative approach is to print a 3D dielectric substrate and metallize the surface using a printing various conductive pastes or paint but this limits the conductor to surface of the printed substrate unless a multi-step fabrication process is used.

In this work, we demonstrate a new method for fabricating antennas using a 3D printing process that lends greater freedom to the conductor shape and orientation. First, a dielectric medium containing a number of defined cavities (via a sacrificial wax substrate) with a large filling port and small diameter outlet holes is printed using a conventional photo-curing inkjet technique. The cavities are then filled with a liquid metal alloy (75.5% gallium, 24.5% indium) by vacuum pressure. The conductive device is thereby packaged in a block of dielectric media and an RF connector seals the filling port using a UV-curable glue. This approach enables geometries that cannot be readily fabricated using planar fabrication techniques or machining. We will describe transmission lines and antennas fabricated in this manner, from small capillary-like structures to high aspect ratio features such as ground planes. Through further refinement of this approach, complex array feeds and antennas can be packaged within a single block of material.