Conductivity of 3D Printed Aluminum and Electroplated Printed Aluminum Measured at Microwave Frequencies

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As technology advances, more efficient methods of manufacturing are developed. This has led to a growing interest in the use of 3D metal printing as a means of producing microwave communication components for satellite and space applications. 3D printing technology brings many benefits to the field of microwave engineering including optimization of manufacturing steps, producing complex parts that are realized in a single piece, and having the ability to design intricate parts all while maintaining a low mass. Using 3D printing to manufacture microwave communication components can eliminate many time consuming steps commonly found in traditional production methods such as milling, turning, and electro discharge machining. 3D printing also allows for the production of single bodied complex parts. Traditional methods of machining rely on the simplicity and accessibility of a part, and so the creation of components is limited. Often times, traditional production methods require simple designs to be bolted together, resulting in antenna components that consist of multiple assemblies. 3D printing has the potential to reduce the number of components in an antenna due to its ability to form complex structures that are otherwise impossible to machine with traditional manufacturing techniques. Reducing the number of assembled components and producing complex designs can also cut down the mass of antennas.

Although 3D metal printing has many benefits, it is still a relatively new process, and the effects on the performance of microwave components have not been fully explored. Currently, 3D metal printing does not produce the same surface finish and dimensional tolerance as traditional machining methods. The high surface roughness could negatively affect the electrical conductivity of a printed component. Since electrical conductivity at microwave frequencies relies on a smooth surface to propagate, a rough surface could be an issue. Similarly, the electrical properties of the printed aluminum alloy ($AlSi_{10}Mg$) may change the antenna performance compared to a high strength Al alloy. In addition to surface roughness, the most accurate 3D metal printer has a tolerance of 0.004"whereas most machined parts have a tolerance of 0.0005". The looser tolerances may affect the signal output of a printed component.

The purpose of this work is to examine the viability of 3D printing is as a means of producing and manufacturing microwave communication components. Ku-frequency resonant cavities are designed and produced on an EOS DMLS printer. The conductivity of the 3D printed aluminum cavities is measured at microwave frequencies. The results are compared to machined 3D printed aluminum cavities and 3D printed aluminum cavities electroplated with gold, copper, and silver.