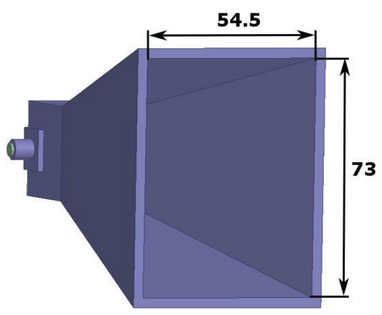
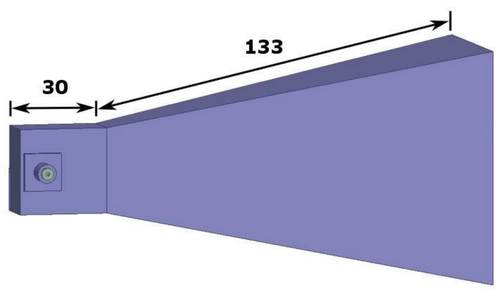
3D Printing of Novel Light Weight X-band Horn Antenna and Lens

Abstract This poster presents the design and 3D manufacture of a low cost, easy assembly, light weight, X-Band horn antenna. The antenna, waveguide feed and pyramidal horn flare are printed as a single piece from Acrylonitrile Butadiene Styrene (ABS). Different metal coating and application techniques are investigated to provide a uniform 40 micron thick metal layer on the ABS surfaces. An important design feature is the waveguide section is fabricated such that "push fitting" a coaxial probe in a single easy operation results in an optimum impedance match .

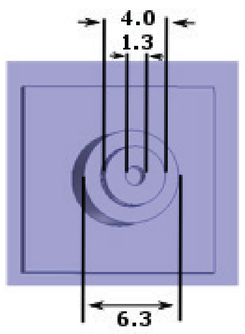
Horn Antenna Design and 3D Print Fabrication



(a) Front view



(b) Side view



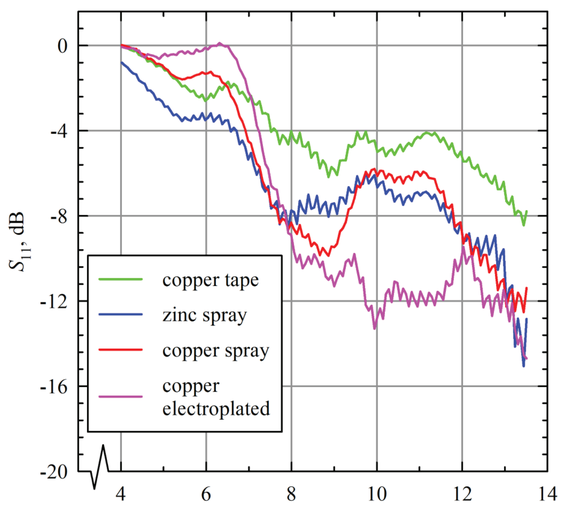
(c) Coaxial matched feed detail

(d) 3D printed horn

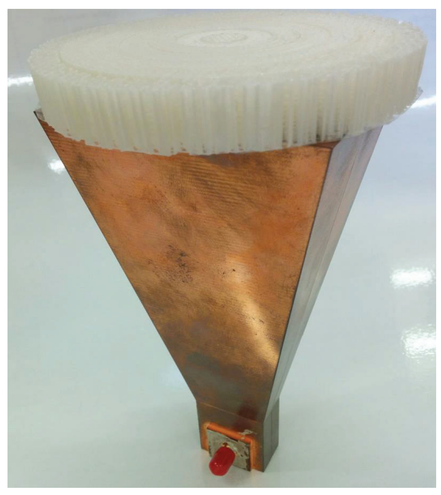
Dimensions of the X-Band horn antenna calculated from microwave simulations of the geometry given in (a), (b) and (c). The 3D printed horn in ABS plastic is shown in (d).

Effect of Metal Coatings on the Matched Antenna

Several different metal types and coating processes were trialled to achieve a uniform 40 micron thick metal coating on the 3D printed part. Spray coating and adhesive taping had undesirable affects on impedance match. Copper electroplating resulted in good surface finish and quality of antenna impedance match.

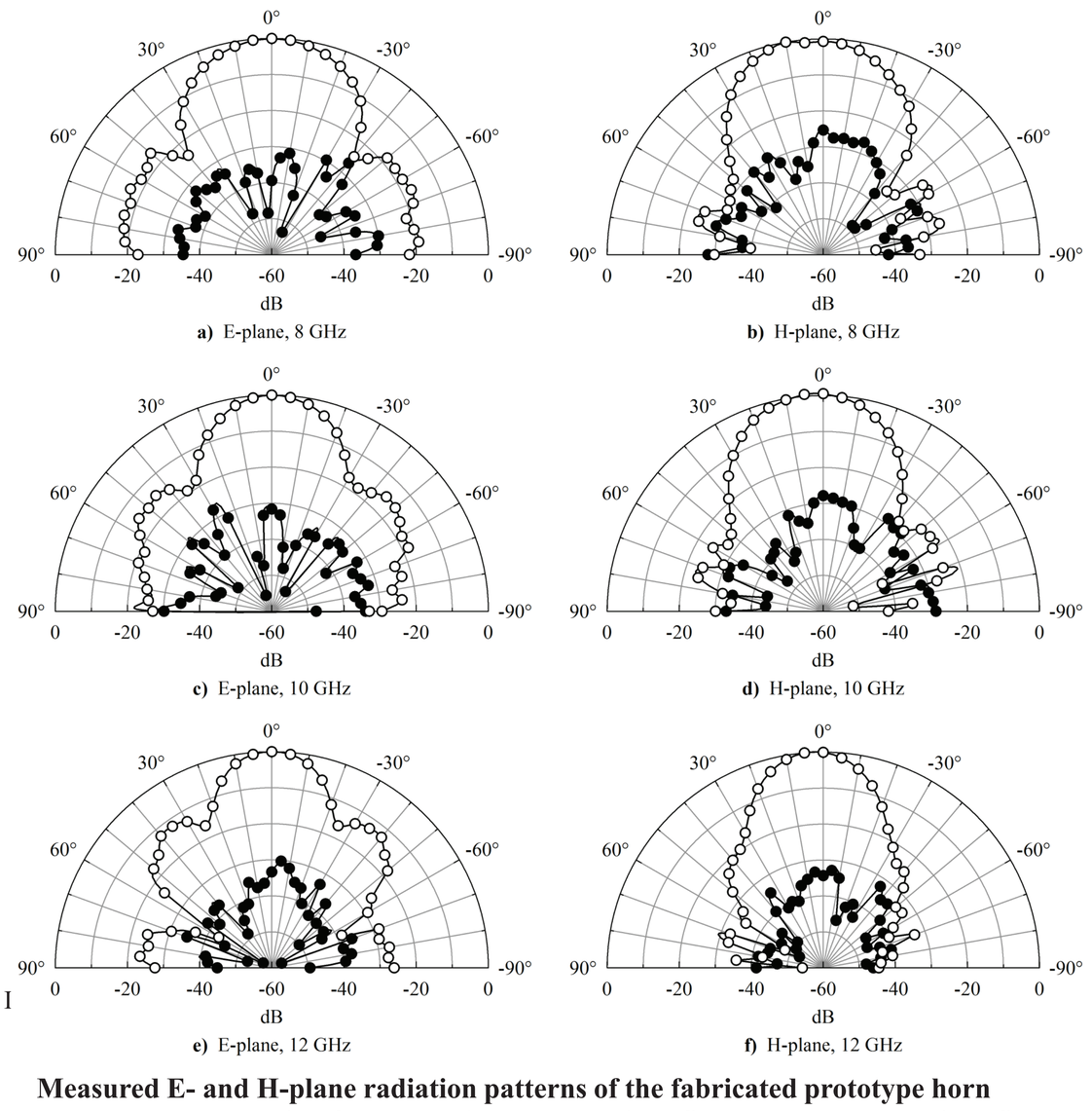


Measured reflection coefficient S_{11} response for matched waveguide probe with different metal coatings applied to the surface of the 3D printed horn antenna.



3D printed antenna with copper electroplating and coaxial matched feed. Also shown in the antenna aperture is a 3D printed lens.

Measured Performance Results



a) E-plane, 8 GHz

b) H-plane, 8 GHz

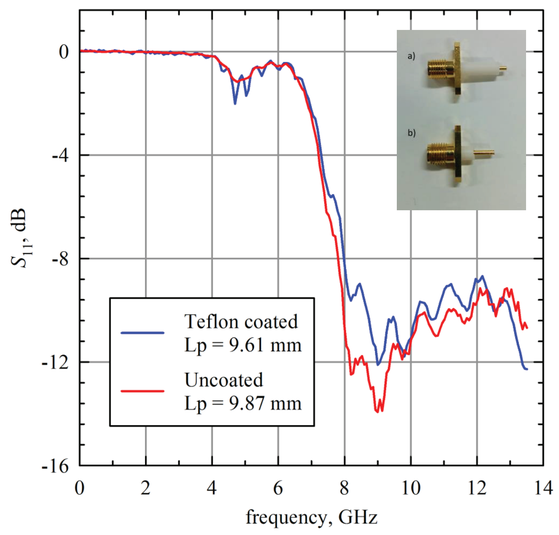
c) E-plane, 10 GHz

d) H-plane, 10 GHz

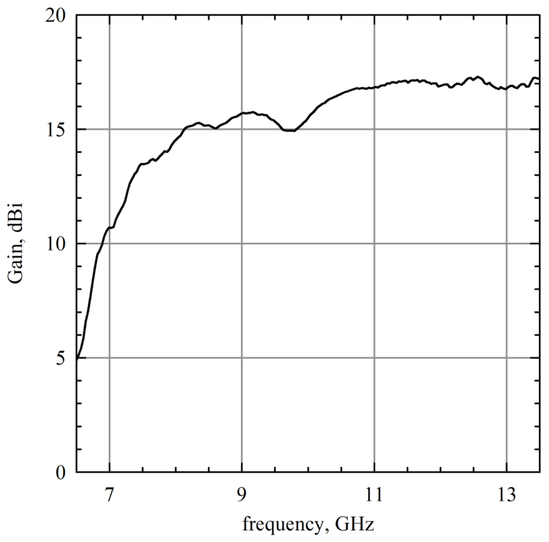
e) E-plane, 12 GHz

f) H-plane, 12 GHz

Measured E- and H-plane radiation patterns of the fabricated prototype horn antenna over operating frequency (○-○ co-polarised field; ●-● cross-polarised field).



Comparison of optimised S_{11} response for probe (a) Teflon coated and (b) uncoated.



Measured gain characteristic of the 3D fabricated horn antenna.

Conclusion A novel X-band horn antenna has been 3D printed and the surfaces copper electroplated. The measured antenna radiation patterns are symmetric and single lobed with a monotonically increasing gain of 10-17 dBi, and impedance matched to <10 dB, over an 8.2 - 12.4 GHz frequency range. The resulting antenna has comparable performance to commercial milled or cast horn antennas but is fabricated for a fraction of the cost and 60% lighter in weight. The antenna is suitable for a wide range of remote sensing applications.

Sebastian Wirth, Dr. Ivor L. Morrow, Dr. Mark Finnis

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