QUANTITATIVE ASSESSMENT OF ADDITIVE MANUFACTURING FOR VACUUM ELECTRONICS IN THE Ka BAND FREQUENCY RANGE

C.G. Whyte[1], C.R. Donaldson[1], K.M. Donaldson[2], D. C. Speirs[1], K.J. Wilson[1], K. Ronald[1], S. Tammas-Williams[2], K. Uzdowski[2], E. Schamiloglu[3] C.W. Robertson[1], P. MacInnes[1], A.R. Young[1] and A.J. MacLachlan[1]

[1] Department of Physics, SUPA, University of Strathclyde, Glasgow, G4 0NG, U.K.
[2] University of Edinburgh, Edinburgh EH9 3FB, UK
3 University of New Mexico, Albuquerque, NM 87131-0001 USA
E-mail of corresponding author: Colin.Whyte@strath.ac.uk

ABSTRACT

Vacuum electronics depends on achieving phase synchronism between streams of electrons and electromagnetic waves, usually confined by a waveguide. Many techniques require subtle metallic structures with complex mechanical connectivity to mediate the phase speed of the electromagnetic signals over a range of frequencies to enable this synchronism. The emergence of additive manufacturing techniques offers significant potential to impact on this requirement, which is increasingly difficult to meet as feature sizes decrease, to address the needs of applications demanding higher frequencies. Challenges remain however for these novel fabrication methods, as the materials used in vacuum electronics need to be non-porous, must be able to withstand extreme temperatures during fabrication and bakeout procedures, so any inclusions and defects can be problematic. Furthermore, as frequencies increase the effective conductivity of the metallic surfaces decreases, and becomes very sensitive to the surface roughness. This leads to increased microwave power loading of the surfaces and losses in the transmitted signals, whilst larger scale imperfections in the profile can lead to loss in the required wave dispersive behaviour. The Universities of Strathclyde, New Mexico and Edinburgh are therefore undertaking quantitative comparative investigation of the performance of components manufactured by additive methods compared to more conventional electrodeposition.

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