3D Printed Surface Periodic Structures for High Power Microwave Sources

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***Abstract*— "3D printing" or "Additive Manufacturing" has been used to construct a cylindrical Periodic Surface Lattice (PSL) quickly, efficiently and relatively inexpensively. Millimeter wave output of 130 ± 30 kW was measured at a frequency of ~80 GHz. Further experiments are in progress using an upgraded system.**

Keywords- 3D printing; additive manufacturing; periodic surface lattice; high power microwaves; millimeter waves

I. INTRODUCTION

Two-dimensional PSLs have been used successfully in high power microwave sources for several years [1-5]. The present work aims to achieve higher microwave output powers efficiently by using a 2D cylindrical periodic surface lattice to couple 4 waves (a forward and backward wave along the axis of the cylinder and a clockwise and anti-clockwise azimuthal wave). This controls the transverse modes which can interact with the electron beam in an oversized interaction space [6-9]. Successful 3D printing of metamaterial microwave structures has been reported by French and Shiffler [10].

II. EXPERIMENT

A cylindrical former was 3D printed in wax and used as a mold into which molten silver (92.5%) chromium (7.5%) alloy was cast. The metallic PSL had 16 axial 1.6mm periods and 7 azimuthal periods. After characterization using a millimeter wave VNA, the PSL beam-wave interaction structure was used in the microwave source shown in Fig. 1. An 80 kV, 4 mm outer diameter electron beam was guided through the 7.2 mm inner diameter PSL interaction region using an 18 mm bore 1.8 T solenoid.

III. RESULTS

Mode pattern diagnostics and cut-off filters have been used in initial measurements of the millimeter wave output of 130 ± 30 kW at a frequency of ~80 GHz. Advances in new metamaterial structures [11] may stimulate further development of 3D printing.

Figure 1 Photograph of 2D PSL high power mm-wave source showing the Blumlein pulser, diode, output horn and window.

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