Contribution ID: **946** Type: **Oral**

Experimental Results of a Metamaterial-Enhanced Resistive Wall Amplifier Prototype*

Wednesday 26 June 2019 10:45 (15 minutes)

Theory and simulation predict the Metamaterial-Enhanced Resistive Wall Amplifier (MERWA) could be developed into a high power amplifier with wide instantaneous bandwidth[1]. Similar to a Resistive Wall Amplifier and Easitron[2], the MERWA produces exponential slow space charge wave growth for a velocity modulated beam. In contrast to the Resistive Wall Amplifier and Easitron, our research suggests the MERWA's slow space charge wave gain occurs in the presence of a lossy metamaterial-circuit's backwards (anomalously dispersive) electromagnetic wave. Due to the backward wave interaction and associated risk of backward wave oscillation, an important tradeoff exists involving the amount of circuit loss and its effect on oscillation, bandwidth, and gain. Prototype metamaterial circuits made of meandered wires[3] have been constructed out of copper (low loss) and stainless steel (high loss) for the purpose of proof-of-concept experiments to verify existence of MERWA gain. This talk will summarize results of simulated models and experimental hot test measurements using the prototypes including effects of varying circuit loss or introducing severs to prevent oscillation.

1. T. Rowe, J. H. Booske, and N. Behdad, "Metamaterial-Enhanced Resistive Wall Amplifiers: Theory and Particle-InCell Simulations,"IEEE Trans. Plasma Sci., vol. 43, no. 7, 2015, pp. 2123-2131.
2. C. K. Birdsall and J. R. Whinnery, "Waves in an electron stream with general admittance walls," Journal of Applied Physics, vol. 24, no. 3, pp. 314-323, 1953.
3. T. Rowe, N. Behdad, and J. H. Booske, "Metamaterial-Enhanced Resistive Wall Amplifiers Design Using Periodically Spaced Inductive Meandered Lines,"IEEE Trans. Plasma Sci., vol. 44, no. 10, 2016, pp. 2476-2484.

*Work supported by the Air Force Office of Scientific Research under Award No. FA9550-16-1-0509 and by a graduate fellowship from the Directed Energy Professional Society.

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Session Classification: 2.1 Intense Beam Microwave Generation

Track Classification: 2.1 Intense Beam Microwave Generation