

Accomplishments of the Microwave Power Research Initiative

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Reported research pertains to an L-band and a W-band signal source.

Research performed under the auspices of the Microwave Power Research Initiative (MiPRI) between May 1, 2005 and April 30, 2006 has been reported. [The MiPRI is a congressionally mandated Air Force program to advance the science of high-power electron- beam-driven microwave and millimeter- wave signal sources.] The reported research was performed by a consortium of three universities led by the University of New Mexico and including the University of Michigan and the Massachusetts Institute of Technology (MIT). The research pertains to two signal sources of current interest to the Air Force: a relativistic Lband magnetron and a W-band source.

The topics addressed in this research at each of the three locations is summarized as follows:

University of New Mexico — A transparent cathode C, essentially a longitudinally slit cylindrical cathode comprising multiple strip electron emitters arranged in a circle C, was proposed as a means of improving the output characteristics of a relativistic magnetron or a free-electron laser. The behavior of a coaxial-diode relativistic magnetron containing a transparent cathode operating with applied crossed electrostatic and magnetostatic fields was simulated by use of a relativisticparticle- in-cell computer code called "MAGIC." The results of the simulations and preliminary results of experiments were interpreted as signifying that, as expected, the transparent cathode offers advantages over a conventional solid cathode.

University of Michigan — Progress has been made in one experimental, one engineering, and four theoretical research projects. The experimental project included fabrication and testing of a three-section cathode intended to implement a combination of cathode-priming and transparent-cathode concepts. The engineering project consisted mainly of design studies to determine what modifications must be made in the University of Michigan laboratory equipment to enable testing of the transparent cathode developed at the University of New Mexico. One of the theoretical projects, performed in collaboration with the University of New Mexico, explored the feasibility of using surface plasmons as sources of coherent terahertz radiation. Another continuing theoretical project in collaboration with the University of New Mexico examines models of cathode priming and transparent cathodes, and includes optimization studies. Yet another of the theoretical projects, which also continues, addresses the effects of manufacturing errors on the performances of microwave tubes. The remaining project, about to begin at the time of reporting, is to involve theoretical analyses of the effects of a nonuniform work function on the emission from a cathode.

Massachusetts Institute of Technology — A design study of an overmoded interaction circuit for a W-Band (94-GHz) slow-wave traveling-wave-tube capable of 100 kW of power in short pulses was performed. The goals of the study included investigation of various kinds of interaction structures to obtain high interaction impedance and bandwidth. Also investigated were interaction circuits made of photonic-bandgap structures that would accommodate overmoded operation, thereby enabling increases in average power by at least an order of magnitude over power levels achievable using interaction circuits of prior design. These structures should also enable progression to higher frequencies, including terahertz frequencies.

This work was done by Edl Schamiloglu, John Gaudet, Mikhail Fuks, Herman Bosman, Sarita Prasad, and Andrey Andreev of the University of New Mexico; Ronald Gilgenbach, Y. Y. Lau, and Ryan Edgar of the University of Michigan; and Richard J. Temkin of Massachusetts Institute of Technology for the Air Force Research Laboratory. For further information, download the free white paper at www.defensetechbriefs.com under the Electronics/Computers category. AFRL-0004