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Plasma Physics Challenges of MM-to-THz and High Power Microwave Generation

JOHN BOOSKE[1], University of Wisconsin-Madison

Homeland security and military defense technology considerations have stimulated intense interest in mobile, high power sources of millimeter-wave to terahertz regime electromagnetic radiation, from 0.1 to 10 THz. While sources at the low frequency end, i.e., the gyrotron, have been deployed or are being tested for diverse applications such as WARLOC radar and active denial systems, the challenges for higher frequency sources have yet to be completely met for applications including noninvasive sensing of concealed weapons and dangerous agents, high-data-rate communications, and high resolution spectroscopy and atmospheric sensing. The compact size requirements for many of these high frequency sources requires miniscule, micro-fabricated slow wave circuits with high rf ohmic losses. This necessitates electron beams with not only very small transverse dimensions but also very high current density for adequate gain. Thus, the emerging family of mm-to-THz e-beam-driven vacuum electronics devices share many of the same plasma physics challenges that currently confront "classic" high power microwave (HPM) generators [1] including bright electron sources, intense beam transport, energetic electron interaction with surfaces and rf air breakdown at output windows. Multidimensional theoretical and computational models are especially important for understanding and addressing these challenges. The contemporary plasma physics issues, recent achievements, as well as the opportunities and outlook on THz and HPM will be addressed. [1] R.J. Barker, J.H. Booske, N.C. Luhmann, and G.S. Nusinovich, Modern Microwave and Millimeter-Wave Power Electronics (IEEE/Wiley, 2005).

[1]Electrical and Computer Engineering Department