MICROFABRICATED TRAVELING WAVE TUBES FOR THZ REGIME RADIATION SOURCES

Welter, J.D.[1], Booske, J.H.[1], Bhattacharjee, S.[1]
, Limbach, S.[1], Jiang, H.[1], Genack, M.[1]
, van der Weide, D.W.[1], Sengele, S.[1], Kory, C.L.[2]
, Ives, R.L.[2], Read, M.E.[2]
[1]Electrical and Computer Engineering, University of Wisconsin, Madison, WI 53706
[2]Calabazas Creek Research, Inc., 20937 Comer Drive, Saratoga, CA 95070

Abstract Submission Form

2004 National Radio Science Meeting

Abstract: booske584

Date Received: September 23, 2004

1. (a)
   John Booske
   University of Wisconsin
   Electrical and Computer Engr
   1415 Engineering Drive
   Madison, WI
   53706 USA
   booske@engr.wisc.edu

   (b) 608-262-8548

   (c) 608-890-0141

2. D - Electronics and Photonics

3. (a)

4. C - Contributed Paper

5. No special instructions

The Terahertz (THz) and sub-THz regions of the electromagnetic spectrum (approximately 100 to 3000 GHz in frequency or 0.1 to 3.0 mm free space wavelength) have enormous potential for advanced communications, radar, imaging, spectroscopy, trace chemical detection, surveillance, medical imaging and space and biological research. The critical barrier to full exploitation of this frequency band is a lack of compact, powerful (1 to 1000 mW) coherent radiation sources. Suitable solutions should be efficient, frequency agile ($\geq 1\%$ instantaneous bandwidth), compact, and relatively inexpensive. Efficient generation of significant power at these frequencies is a serious challenge for solid state electronics, due to charge carrier mobility limitations. In principle, slow wave vacuum devices (e.g., traveling wave tubes or klystrons) should provide attractive opportunities. For example, the mobility of collisionless electrons in a vacuum is extremely high. However, conventional fabrication methods can not reliably manufacture the small circuit dimensions required at these high frequencies.

We are investigating the prospects for adopting MEMS technologies to fabricate THz regime vacuum traveling wave tubes (TWTs). TWTs offer a much-needed amplifier technology with considerable bandwidth, they are more tolerant of circuit ohmic losses than klystrons, and they can be operated as both oscillators and amplifiers. The folded waveguide (FWG) slow wave circuit has been selected as one which offers attractive electronic characteristics (significant bandwidth and interaction impedance) while remaining readily compatible with planar microfabrication techniques. Recent achievements will be discussed including computational evaluation of THz TWT oscillators and amplifier conceptual designs. A novel adaptation of the conventional FWG circuit in which a waveguide gap replaces the conventional "beam tunnel" has been shown to be a viable, easily-fabricated means to allow for passage of the electron beam. We have also completed preliminary experimental evaluation of several microfabrication technologies, including x-ray LIGA, UV LIGA, and silicon deep reactive ion etching (DRIE). Of these three, DRIE offers the greatest appeal in terms of ease, speed, and precision of fabrication.