Generation of Terahertz Regime Radiation by Microfabricated Folded Waveguide Traveling Wave Tubes

S. Sengele, H. Jiang, J. H. Booske, D.W. van der Weide, S. Limbach, A. Mashal, B. Yang, A. Marconnet, M. He, P. Larsen

Department of Electrical and Computer Engineering
University of Wisconsin – Madison
1415 Engineering Drive, Madison, WI 53706-1691
email: smsengele@wisc.edu, Tel: (608) 265-3981

Abstract: *The fabrication of a Terahertz regime folded waveguide traveling wave tube (FWTWT) using MEMs microfabrication techniques is currently underway. Recent developments in the design, fabrication method, and measured data will be presented.*

Keywords: terahertz source; traveling wave tube; MEMs; sub-millimeter wave

Introduction

There is enormous technological potential for the Terahertz (THz) and sub-THz regimes of the electromagnetic spectrum (approximately 100 – 3000 GHz in frequency or 0.1 to 3.0 mm free space wavelength). The development of THz sources could lead to advances in communications, radar, imaging, spectroscopy, trace chemical detection, surveillance, medical imaging and space and biological research [1]. Wideband sources at high frequencies would enable very high data rate wireless communications. In contrast to infrared or visible optical data links, THz communications can be conducted in the presence of fog or smoke. Adequate power sources in the THz regime would enable imaging of biological tissues, where specific absorption rates (SARs) are large, and hence require more power. In fact, the THz regime may well be the most scientifically rich, yet underutilized region of the spectrum.

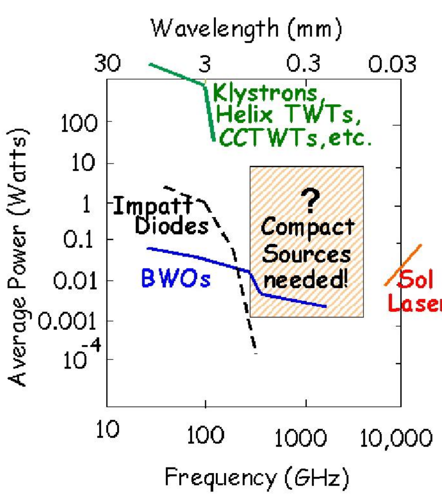

Figure 1. Compact coherent radiation source capabilities.

400 GHz TWT

As a part of our studies on THz regime radiation sources we are investigating the utility of MEMS microfabrication techniques in producing 400 GHz vacuum traveling wave tubes (TWTs) .

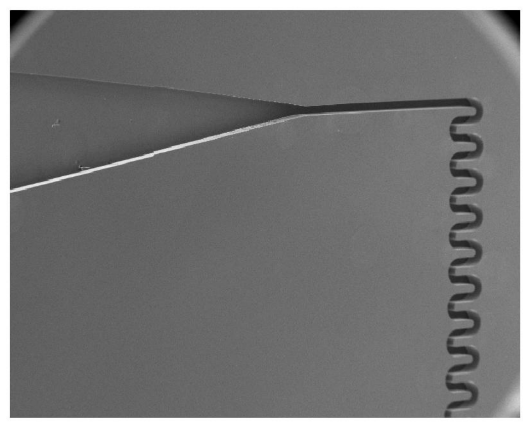

Figure 2. SEM image of 400 GHz folded waveguide TWT half with horn antenna

TWTs are attractive for numerous reasons. They offer considerable bandwidth, they are more tolerant of circuit ohmic losses than other vacuum electronic circuits, 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 [2,3]. A novel adaptation of the conventional FWG circuit—introduction of a waveguide gap—has been computationally and experimentally verified as a viable, easily-fabricated alternative to the conventional "beam tunnel" for passage of the electron beam.

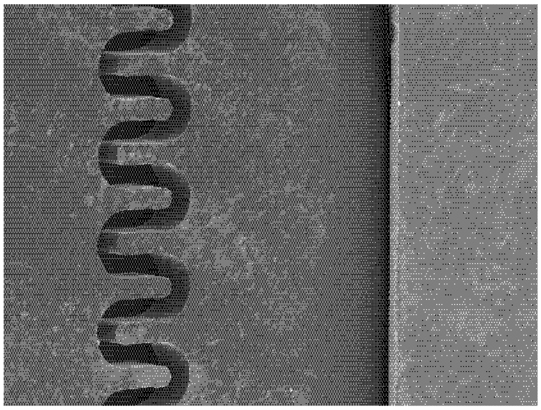

Figure 3. Close-up of spacer used to create electron beam gap

Recent achievements have included process evaluation and refinement of microfabrication techniques including silicon deep reactive ion etching (DRIE) and wafer-level bonding. A comparison between regenerative (external feedback) and backwards wave oscillator configurations has been conducted, examining tradeoffs in efficiency and design implementation. Additionally, an electron beam facility has been constructed for TWT testing. The most recent results on modeling, component microfabrication, and preliminary measurements of THz radiation will be discussed.

References

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