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F. Bouamrane[a], A. Di Carlo[b], A. Durand[c], M. Kotiranta[d], V. Krozer[d], V. Zhurbenko[e], M. Mineo[f], C. Paoloni[f]

[a] Unité Mixte de Physique CNRS-THALES et Université Paris sud 11, Palaiseau, France

[b]Dept. Elelctronic Engineering, University of Rome Tor Vergata, Rome, Italy.

[c]Thales Electron Devices, Vélizy, France.

[d]Physikalisches Institut, Goethe-Universität Frankfurt, Frankfurt am Main, Germany.

[e]Technical University of Denmark, Kgs. Lyngby, Denmark.

[f]Lancaster University, Lancaster, UK.

Corresponding : E-mail : faycal.bouamrane@thalesgroup.com

The use of Terahertz technology promises encouraging results in applications such as communications, imaging, and sensing due to the fact that the radiation in this frequency range is nonionizing as X-rays, but easily penetrates through many common materials, which can be used for imaging packaging, clothing, shoes, books, bags, etc, and sensing potentially dangerous materials concealed in them. From security point of view, the transmitted and reflected spectra of many materials of interest (explosives, drugs, chemical and biological agents etc.) contain THz absorption fingerprint. Terahertz radiations are considered biologically safe for human being due to their low photon energies unable to cause harmful ionisation.

Different approaches for THz signal generation have been employed over the years. One is based on electronic sources combined with up converters, the other is based on optical type sources producing beating and down conversion from optical frequencies. Nevertheless, all of them still provide low power, are bulky and/or operate at low temperature, so that this general technological state defines what is called THz gap in term of available sources.

In the framework of a European Network, a large consortium of R&D teams merged their competences in order to solve the power/size limitation of THz sources by developing a compact, efficient and reliable novel vacuum THz amplifier to boost power performance of existing sources.

The proposed amplifier is designed on travelling wave tube TWT (Fig. 1) principles. The electron beam is generated by an electron gun where the cathode can be either a thermo electric cathode or a cold CNT (Carbon Nano Tube) cathode. The electrons emitted by the cathode are accelerated by the voltage between the cathode and the anode and properly constrained in the required beam shape. A static magnetic field focusing is required to confine the electron beam in the planar Slow Wave Structure SWS (the interaction structure). The RF field in the SWS causes density and velocity modulation of the electron in the beam to establish the bunching of the electron beam. The output is placed at a proper distance from the input port, where the bunches are decelerated and transfer energy to the RF field. A collector dissipates the electron beam power at the end of the tube. The SWS is of a new type [1] and is called “Double Corrugated Wave” guide : the electron beam is travelling between the two periodic structures. LIGA was chosen as one technology to process SWS and several technological improvements have been developed during the project to finalize structures.

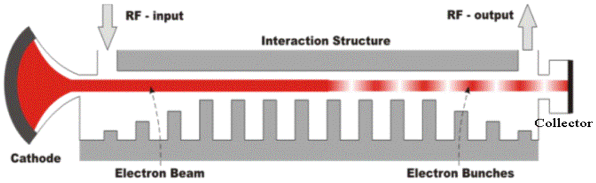

Fig. 1: Schematic drawing of a Travelling Wave Tube

Two examples of realization : a 12mm long SWS made for loss determination and details of the amplifier structure are depicted on Figure 2 and Figure 3 respectively. For the last device, described in [2], the input and output THz RF ports are located in the middle of the TWT.

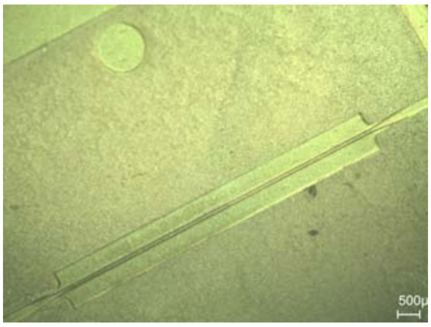

Fig. 2: 12mm long loss measurement SWS structure made by LIGA. Copper teeth height are 65µm +-2µm

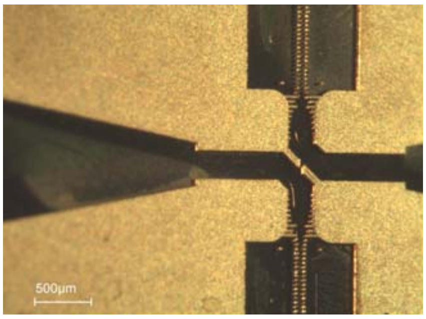

Fig. 3: Copper made LIGA structures showing part of the delay lines, the two coupling structures and parts of the input output horns. Structure height is 58µm +-2µm

References

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[2] V. Zhurbenko, V. Krozer, M. Kotiranta, F. Bouamrane, S. Megtert, T. Bouvet, A. Di Carlo, and M. Dispenza, "Excitation of a Double Corrugation Slow-wave Structure in Terahertz Range," *Proc. of EuCAP2011*, April 2011, Rome, Italy, pp. 1092-1094.

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