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LIGA-based Slow Wave Structure for a THz Vacuum Amplifier

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The specific properties of TeraHertz (THz) radiation such as penetration through packaging materials, clothing, shoes, books, bags, etc allow to use this radiation for detection of potentially dangerous concealed substances in security applications as well as for imaging and spectroscopy. The transmitted and reflected spectra of many materials of security interest (explosives, drugs chemical and biological agents etc.) contain THz absorption fingerprint. Terahertz radiation is considered biologically safe for human being due to their low photon energy unable to cause harmful photo ionisation.

Different approaches for THz signal generation have been employed over the last years. They are based either on multiplication of a signal from low frequency sources or mixing of two optical sources and down conversion from optical frequencies. Unfortunately they provide low power, are bulky and/or operate at low temperature. This technological state defines what is called THz gap in terms of available THz sources.

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

The currently available micro fabrication techniques (UV and X ray lithography / LIGA) impose constraints for device realization: the chosen THz Drive Signal Amplifier is designed to work as a traveling wave tube TWT (Fig. 1). The electron beam is generated by an electron gun where the cathode can be either a micro thermo-ionic cathode or a cold CNT cathode (Carbon Nano Tube). The electrons emitted by the cathode are accelerated by the voltage between the cathode and the anode and shaped in electron beam. A static magnetic field focusing is required to confine the electron beam in the Slow Wave Structure (the interaction structure). The RF field in the SWS causes velocity modulation of the electrons in the beam to establish the bunching of the electron beam. A collector dissipates the electron beam power at the end of the tube.

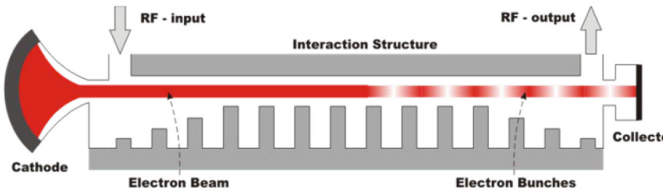
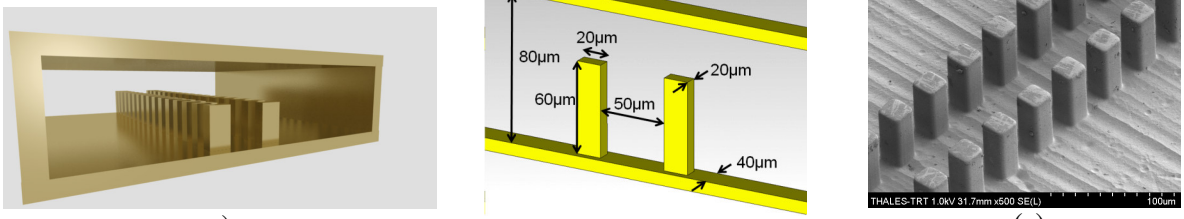


Fig.1 Schematic drawing of a Travelling Wave Tube

The SWS is of a new type [1] and is called "Double Corrugated Waveguide" as shown in Figure2 a, b. X ray LIGA process has been used for the realization of this delay line, a detail of which is shown on Figure 2c.



a) (b) (c)

Fig. 2: a) Schematic cross section of the SWS, b) dimensions of one cell, c) corresponding LIGA structures

A Backward Wave Amplifier (BWA) configuration has been chosen for THz amplifier realization. In a BWA the output port is located at the gun end and the input port at the collector end. The schematic of BWA and X ray LIGA realization of coupling structures are depicted on Figure 3 a,b.

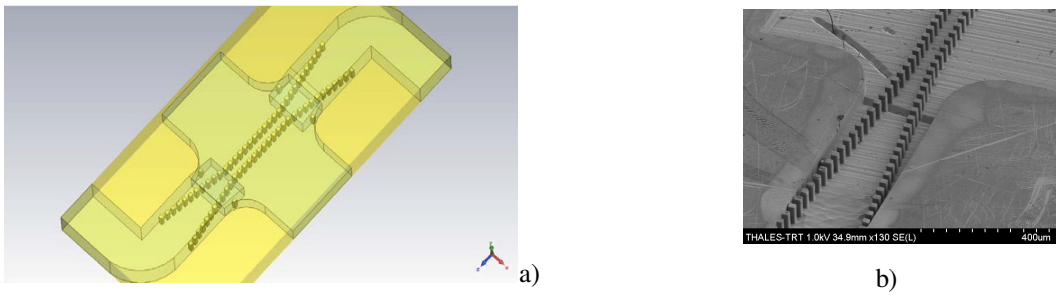

a) b)

Fig. 3: a) Schematic of the BWA amplifier. b) LIGA structures showing the end of the delay line and the coupling structures.

The assembly of the SWS with the other elements of the vacuum tube amplifier (not LIGA made) is in progress.

Reference

M. Mineo and C. Paoloni, "Double Corrugation Rectangular Waveguide Slow-wave Structure for THz Vacuum Devices", *IEEE Trans. on Electron Devices,* vol.57, n.11, pp.3169-3175, November 2010

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