Absorption modulation with semiconductor plasmonic microstructures from 1.1 to 2.5 THz

F. Gonzalez-Posada[$], D.Coquillat[@], M. Najem[$], P.Loren[$], T. Taliercio[$]

[$] *IES, Univ Montpellier, CNRS, Montpellier, France*

[@] *L2C, Univ Montpellier, CNRS, Montpellier, France*

Corresponding author: fernando.gonzalez-posada-flores@umontpellier.fr

Terahertz time domain spectroscopy (THz-TDS) remains so far the backbone of terahertz photonics in numerous applications. [1] Plasmonic microstructures and metasurfaces are particularly promising for improving THz spectroscopy techniques and promising for the development of biomedical and environmental sensors. [2] Highly doped semiconductors are suitable for replacing the traditionally-used noble metals, because their plasmonic behaviors are optically tuned with different geometry, size and interactions (gap effect) also in this spectral range. In figure 1A, a perfect absorber structure based on III-V semiconductor layers is presented on a GaSb commercial substrate template. A photonic absorption peak was targeted in the IR with the thickness of the GaSb spacer on top of a metallic mirror-like doped InAsSb layer. The InAsSb top layer was doped and microstructured to obtain a plasmonic resonance in the THz region. Figure 1B shows the visible light diffraction of the 1x1 mm^2 micro-structure arrays fabricated by electron beam lithography and dry etching. In figure 1C, the darkest 1x1 mm^2 squares correspond to an array of InAsSb linewidth of 14 and 16 μm with a constant pitch of 30 μm. Such contrast is related to the coupling between the plasmonic microstructure array and the incident light at a mean frequency region selected in the THz-TDS measurement. Thus, an intense color indicates a higher electric field in the C-slice view scale. In this particular C-slice view, a 2-2.05 THz mean frequency is selected. Finally, in figure 1D, the THz-TDS measurements of the minimum absorption reached (red dots) correspond with the simulation absorption map calculated by rigorous-coupled wave analysis [3].

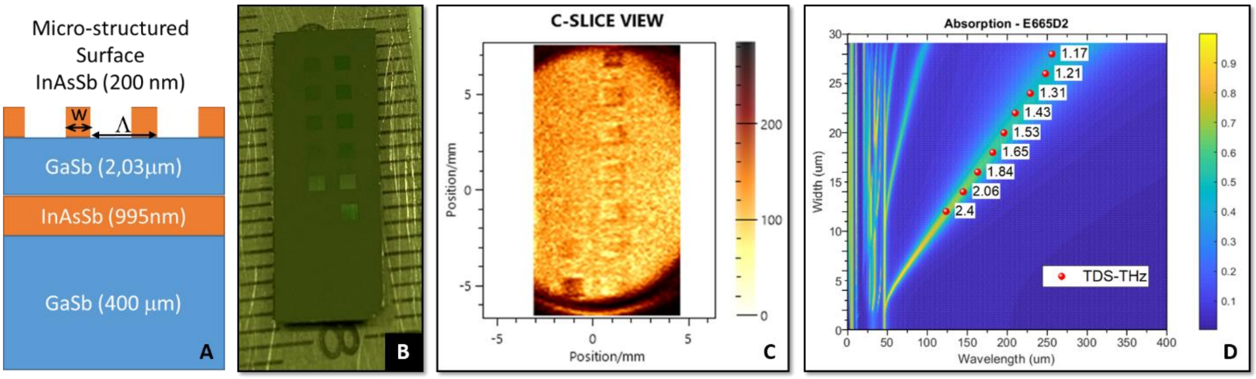

Fig. 1:A) Epitaxial layers from the substrate to the micro-structured surface of InAsSb B) Photograph of the complete transducer sensor with 1x1 mm^2 micro-structured areas with a constant pitch (Λ) of 30 um and variable linewidth (w) from 2 to 28 μm. C) Electrical field of the transducer surface imaged at 2-2.05 THz frequency. D) Simulation of the absorption of the micro-structured surface for different linewidths corresponding to the electromagnetic THz spectral range (Color map). Absorption minimum mean value of six points for each square measured in the THz-TDS experiments. (Red dots and labels)

References:

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