Design and characterisation of Photoswitches for picosecond electric pulses generation at very low temperature

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The electrical ultrafast response of a Two-Dimensional Electron Gas (2DEG) system has been recently investigated at low temperature (4K) using a dedicated optoelectronic mesoscopic device [1]. Such an experiment typically takes benefit from THz technology as it relies on both the use of ultrafast photoswitches (PSW) integrated on-chip with the studied device and time equivalent sampling techniques. Therefore, such an approach should also allow for the time domain studies of 2DEG quantum electronic devices for which the coherence time of a single electron wavepacket (SEW) is typically in the 10-100 ps range [2]. However, the quantum regime of 2DEG requires that the device's temperature is kept below 0.1 K. So, it is mandatory to develop ultrafast PSW that present high optical to electrical conversion efficiency in order to generate, manipulate and detect SEW at a ps time scale without depositing too much optical power onto the chip.
In this talk we will present the recent results that we obtained in the design, simulation and characterization of GaAs based ultrafast PSW dedicated to such quantum electronic experiments. First, we will focus on the different experimental set-ups used for the time domain characterization of PSW and their associated transmission lines (see Fig. 1). Then we will present different PSW designs addressing high optical to electrical conversion efficiency. These PSW involve plasmonic and electromagnetic resonances [3]. They are mainly inspired by 3D structures developed for photovoltaic solar cells [4].

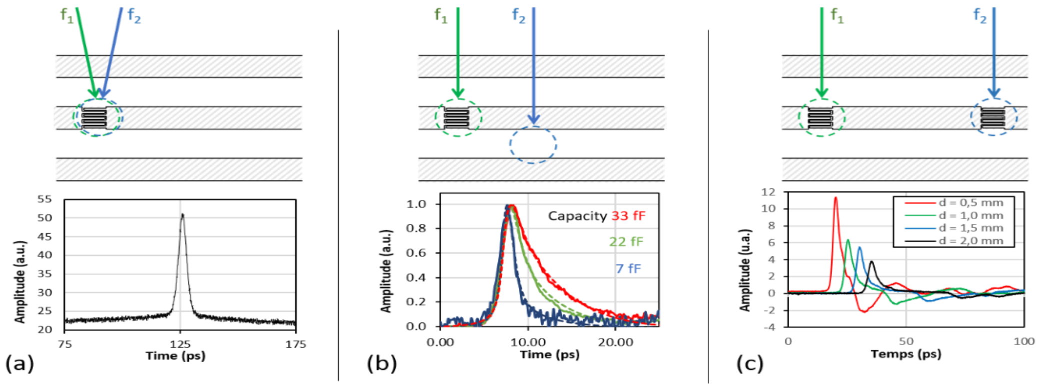

Fig. 1: Characterization of standard interdigitated 2D PSW and coplanar waveguides using different measurement configurations (a) autocorrelation, (b) sliding contact and (c) generation/detection.

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