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# Photogenerated metasurface-based THz Modulator

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In the perspective of filling the lack of THz modulators, previous works have shown the possibility to optically modulate a THz beam crossing an InAs slab [1]. In the continuity of this work, we seek to reduce the required optical power by operating at 1550 nm in order to benefit from the fiber optic technology and to have a better control of the IR beam. Indeed, we show that to work at low power it is necessary to decrease the size of the IR beam to reach very high optical densities and we can thus generate many free carriers in the semiconductor by optical absorption process. The presence of these carriers allows to reach a quasi-metallic effect of the slab in the desired THz range. We can then modulate the transmission of the THz wave crossing the modulator by switching it from an optically unpumped state (dielectric that transmits the THz wave) to an optically pumped state (metal reflecting the THz).

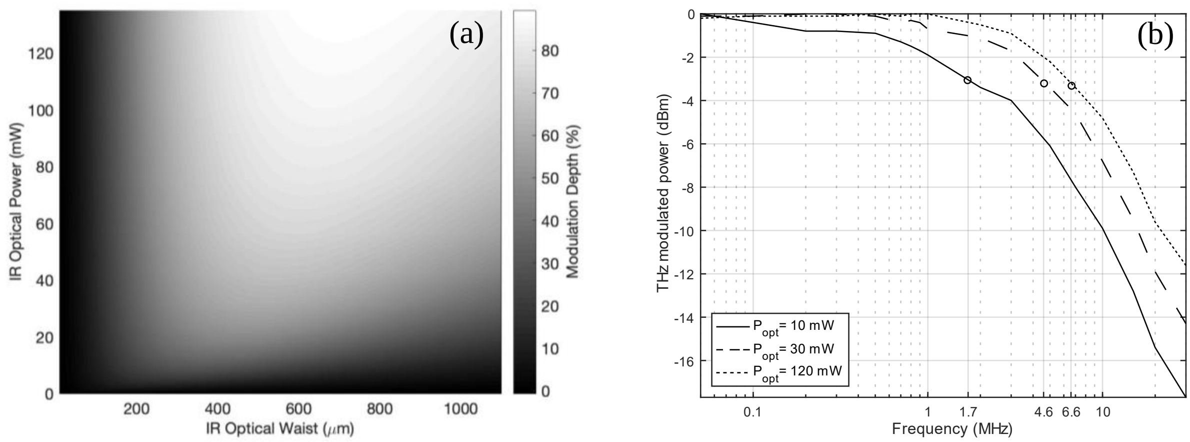


*Fig. 1: (a) map of the THz transmission modulation of a 5 µm-thick InAs slab for different IR waists ($W_{opt}$) and IR powers at THz waist ($W_{THz}$) = 550 µm (b) Experimental Bode for three IR powers with cutoff frequencies.*

As shown in Fig. 1 (a) the MATLAB model shows that using $w_{THz}$ = 550 µm one can achieve up to 90% static modulation in the available IR power range. This optimum is reached when $w_{opt} \approx w_{THz}$ (optimal beam overlap). Using this optimal configuration, we perform the dynamic study of the modulation by plotting the Bode diagrams in (b). It is then shown that when the IR optical power increases, the cutoff frequency increases. Indeed, since the density of photogenerated carriers increases, their lifetime decreases due to the Auger process and the modulator has a faster response.

## References

[1] E. Alvear et al. Appl. Phys. Lett. 117, 111101 (2020).

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