# Low-Loss Plasmonic Resonances in Heavily Doped InAs for Infrared Optoelectronic Integration

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Plasmonic resonances supported by traditional metals (e.g., gold, silver, and aluminum) have been used to enhance optoelectronic devices such as emitters and detectors.[1] However, these materials are very lossy in the infrared region, hindering their use in actual devices that operate in the infrared.[2] To overcome this issue, we use doped III-V semiconductors as a low-loss plasmonic material that can be easily integrated with traditional III-V infrared optoelectronic devices. Here we show that an InAs epilayer, when highly-doped with Tellurium (up to $10^{20}$ $cm^{-3}$), exhibits a plasma frequency corresponding to light at a free-space wavelength of 4.5 µm. When a 1D grating with a period shorter than 5 µm is formed in the epilayer via dry etching, resonances at longer wavelengths (5.5 to 14 µm ) are observed with quality factors around 7 and absorption as high as 95%. Finite element electromagnetic models of the resonances show good agreement with our experimental results. This material is based upon work supported by the Office of the Undersecretary of Defense for Research and Engineering Basic Research Office STTR under Contract No. W911NF-21-P-0024. Disclaimer: The content of the information does not necessarily reflect the position or the policy of the Government, and no official endorsement should be inferred.

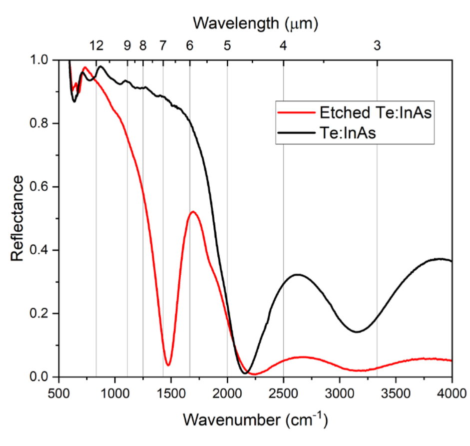


Figure 1: Plasmon Creation

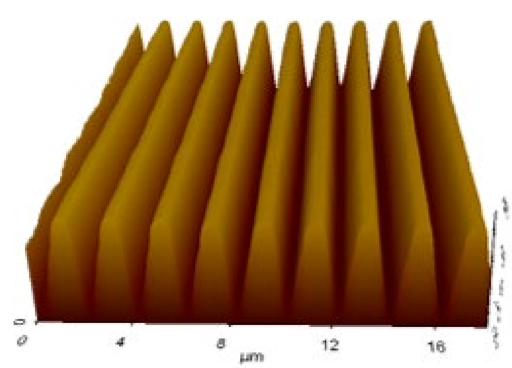


Figure 2: AFM Images

[1] J.A. Nolde et al., "Resonant quantum efficiency enhancement of midwave infrared nBn photodetectors using one-dimensional plasmonic gratings", Appl. Phys. Lett. **106**, (2015) 261109

[2] N. Kinsey et al., "Near-Zero-Index Materials for Photonics", Nature Materials **4** (2019) 742