# Metasurface-enhanced waveguide-integrated graphene phototransistors

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Graphene-based integrated photonic devices have demonstrated broadband absorption (ultraviolet to terahertz), efficient optical modulation, high-speed operation (>200 GHz) and high CMOS compatibility. However, a major bottleneck for on-chip graphene photodetectors is the low quantum efficiency due to the atomic thickness of graphene. To improve the interaction of light with graphene, we developed metasurface-enhanced waveguide-integrated graphene phototransistors. In this study, three on-chip device geometries were used to induce local plasmonic and electrostatic fields. A split-gated phototransistor manipulates local doping in the graphene channel via two parallel gates, resulting in an 80-fold increase in responsivity. In a second device, a plasmonic photoconductor, extreme light confinement was achieved via a plasmon resonance tunable in the range 1.55‑2.4 µm by adjusting the Au metasurface dimension. Finally, we have also demonstrated plasmonic phototransistors with Au/Ti and Au/Pd metasurfaces that exploit both plasmonic and electrostatic fields, achieving a photoresponsivity of 197.3 mA/W and a quantum efficiency of 15.78% at 1550 nm. This unique device creates a graphene p-i-n junction by Fermi level shifting via the asymmetric metallization, while maintaining the plasmonic near-field enhancement. In summary, this study shows that integrated graphene photodetectors are promising and can achieve both high responsivity and high-speed response, even at MIR wavelengths.

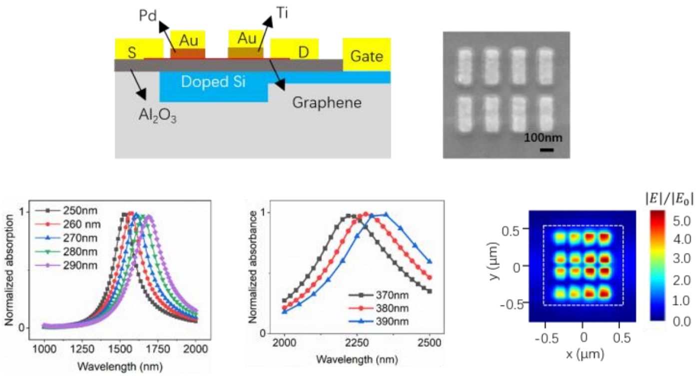


Figure. Device structure and metasurface design of the metasurface-enhanced waveguide-integrated graphene phototransistor

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