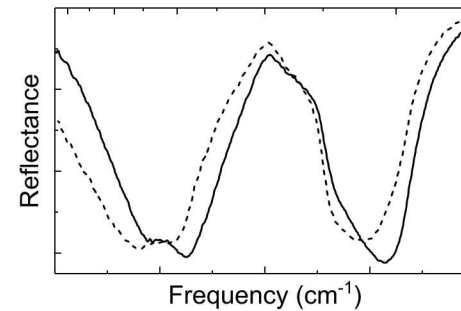
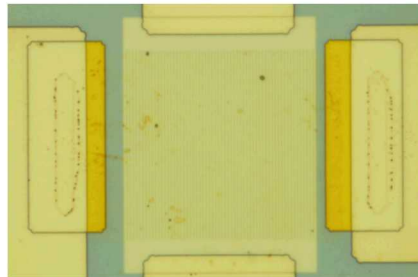
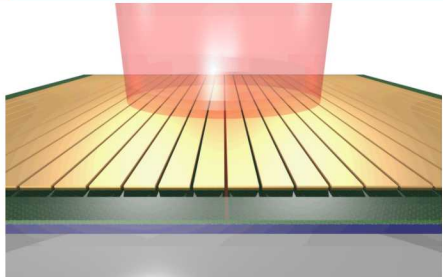


Dual-band Tunable Graphene-Based Filter



PRESENTED BY

Michael Goldflam, Isaac Ruiz, Stephen Howell, Joel Wendt, Michael Sinclair, David Peters, Thomas Beechem



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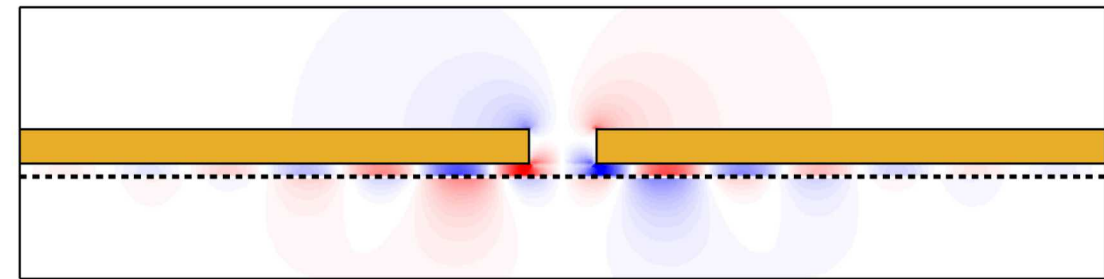
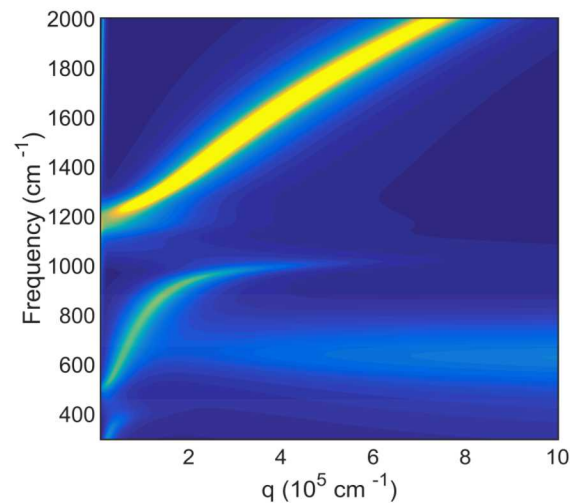
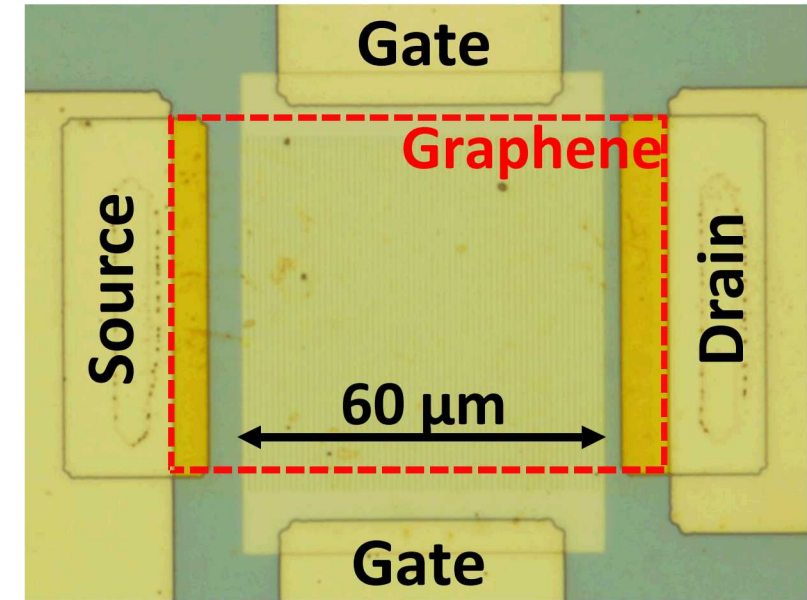
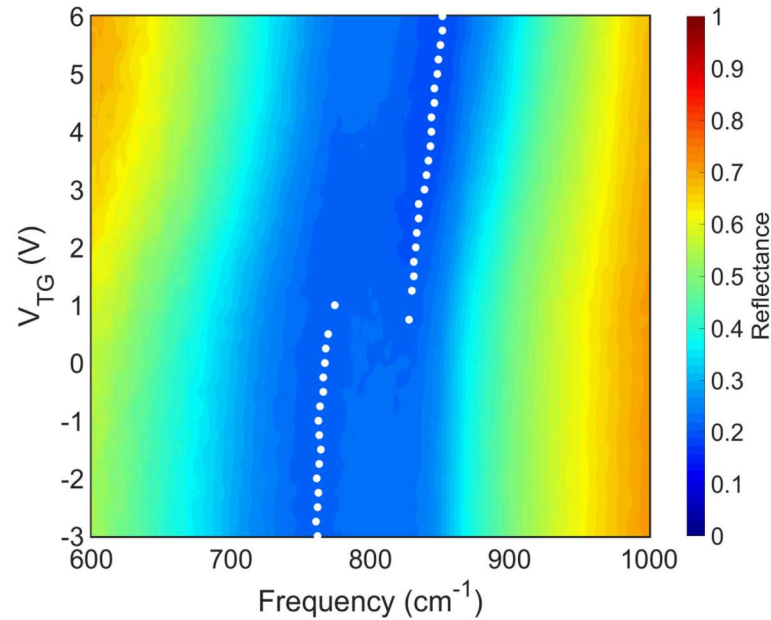
Outline

Graphene

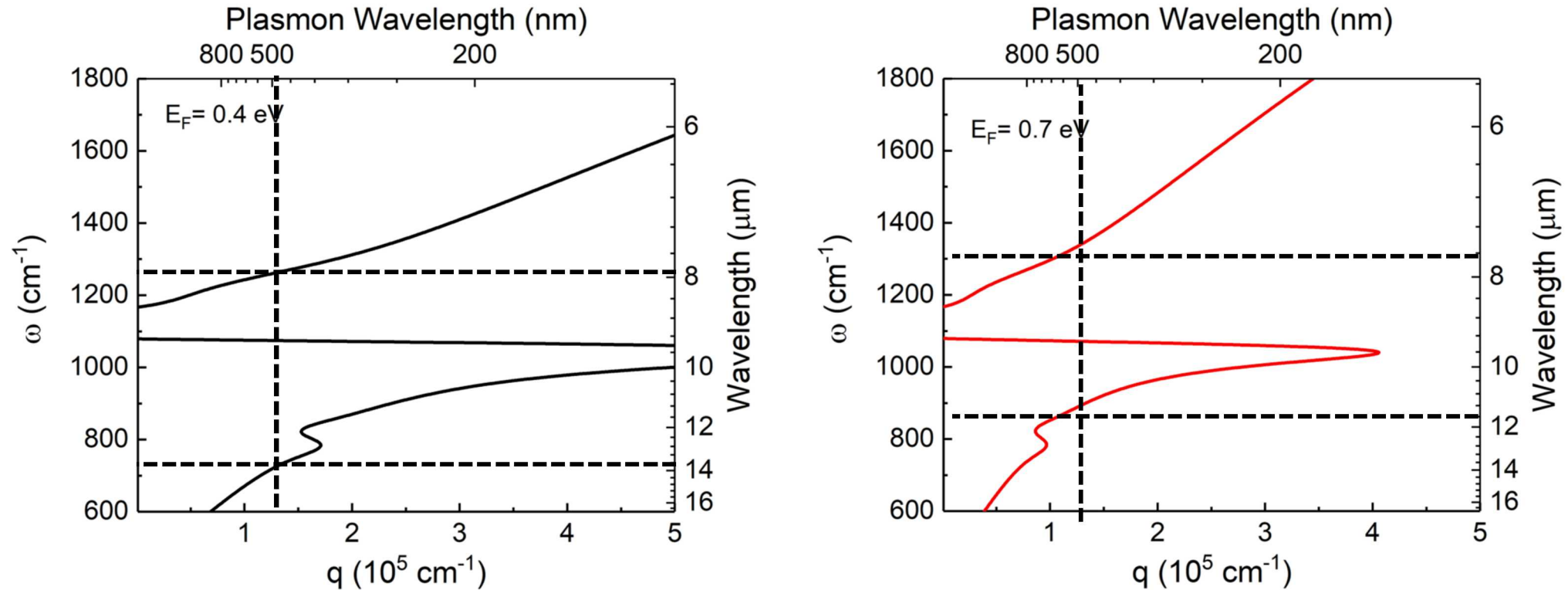
- Tunable plasmonics
- Limitations

Tunable filter

- Ensuring scalability
- Multi-band tunability



Plasmonic Tuning in Graphene

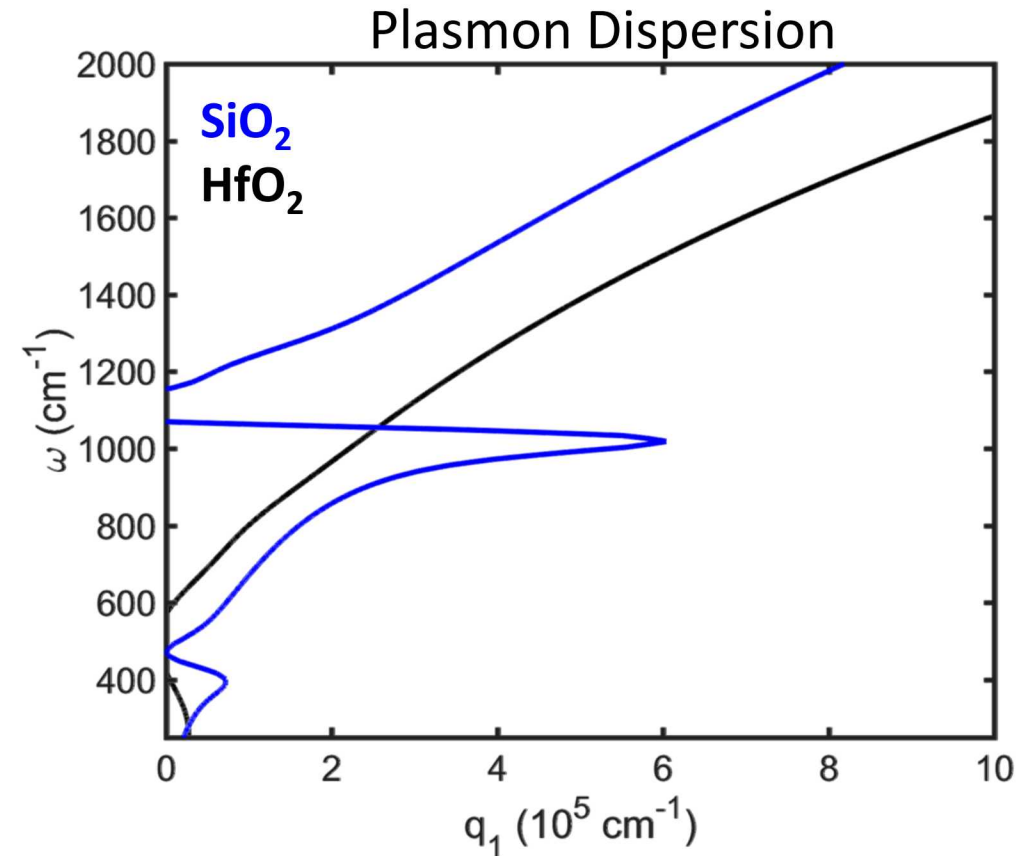
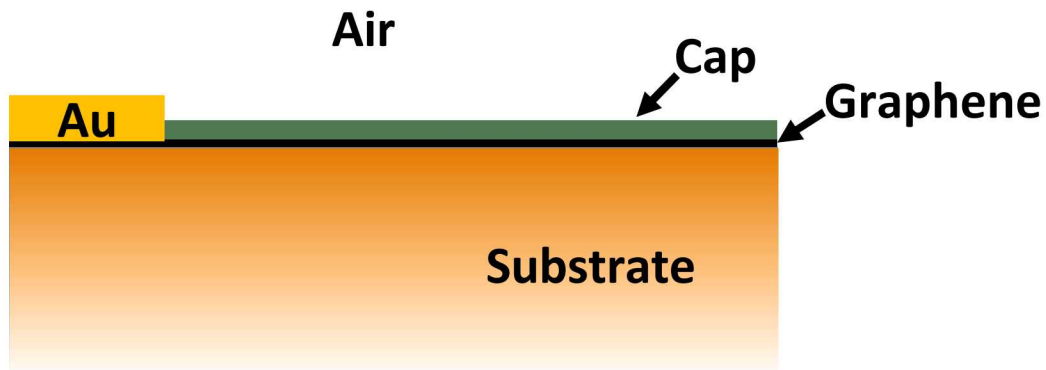


Plasmonic response tuned through carrier injection

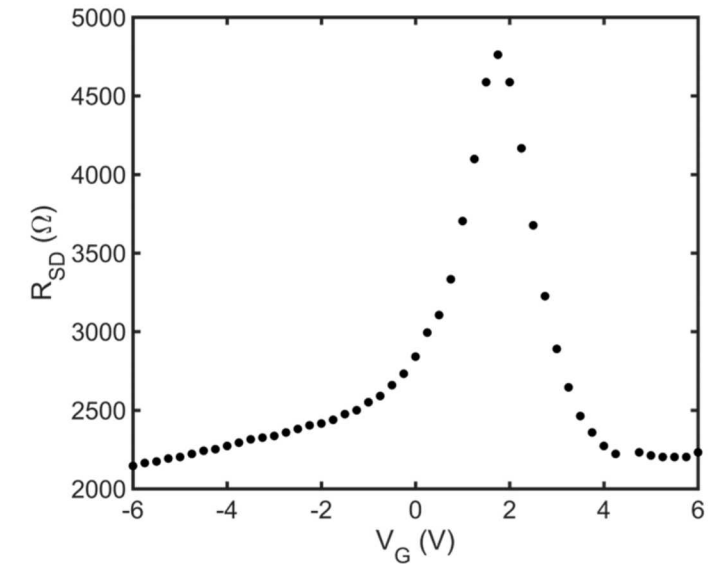
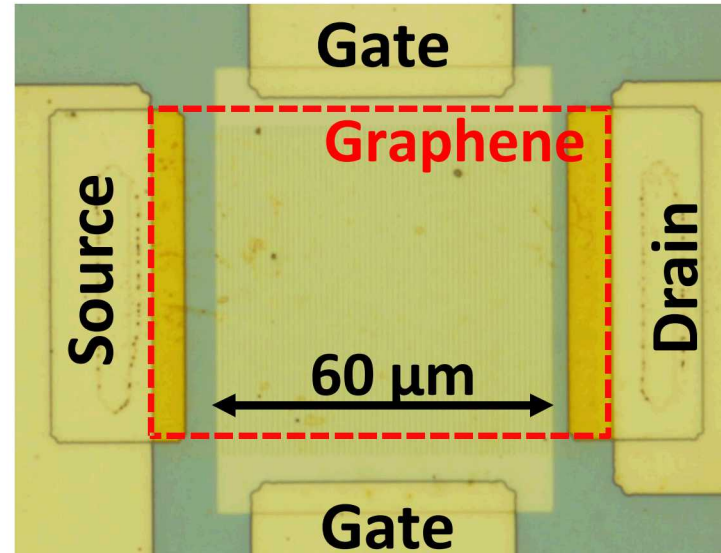
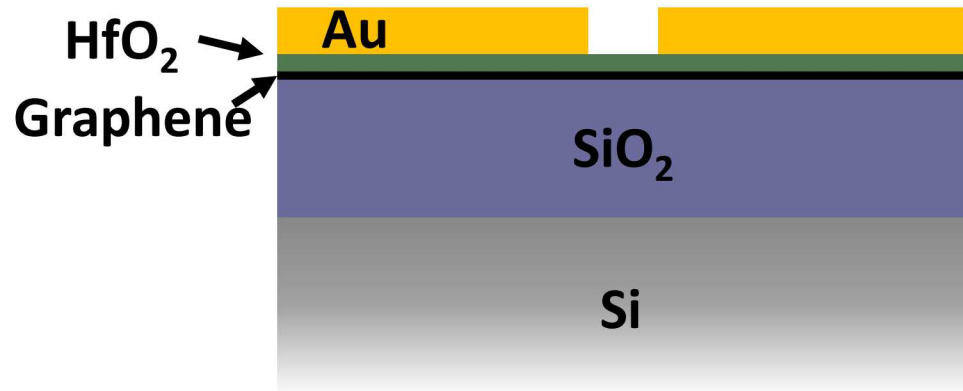
Limitations of Graphene

Graphene changed by environment and fabrication methods

- Fermi level pinning
- Plasmon dispersion modification
- Environmental degradation

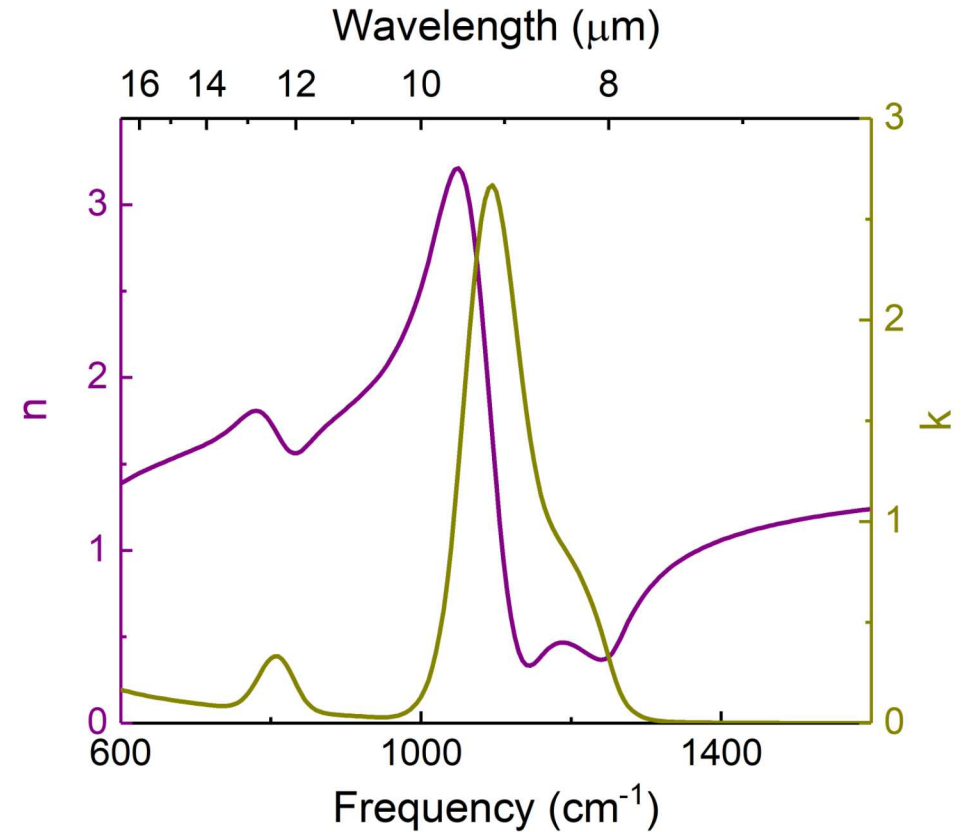
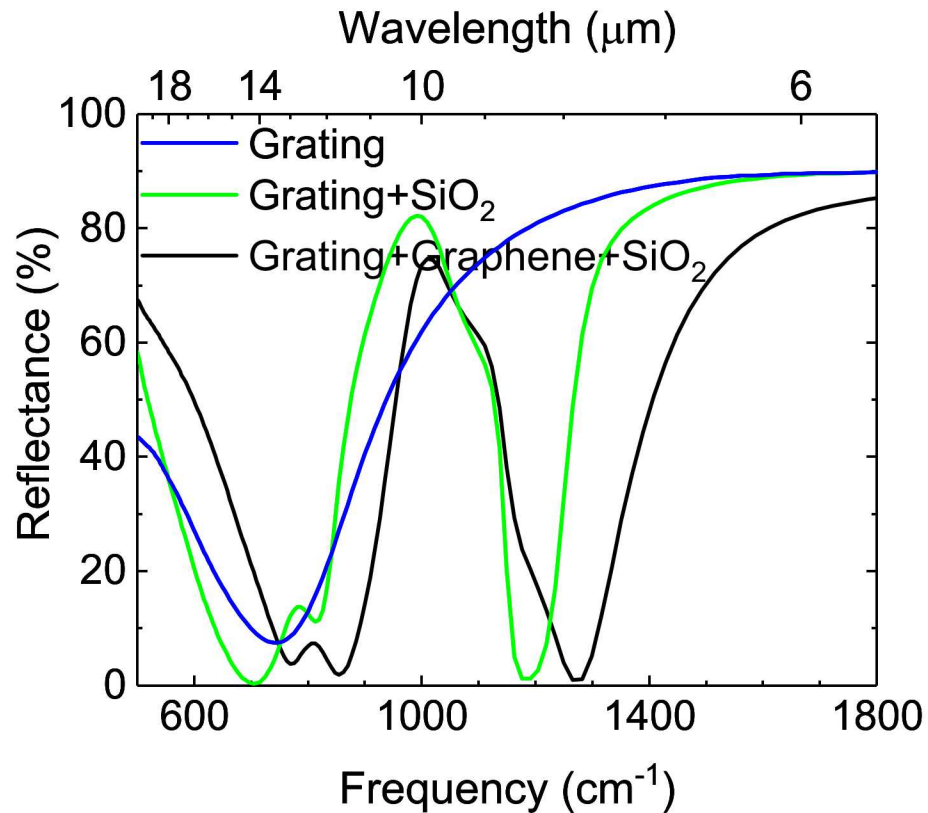


Device Design



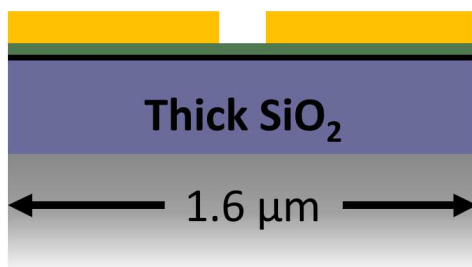
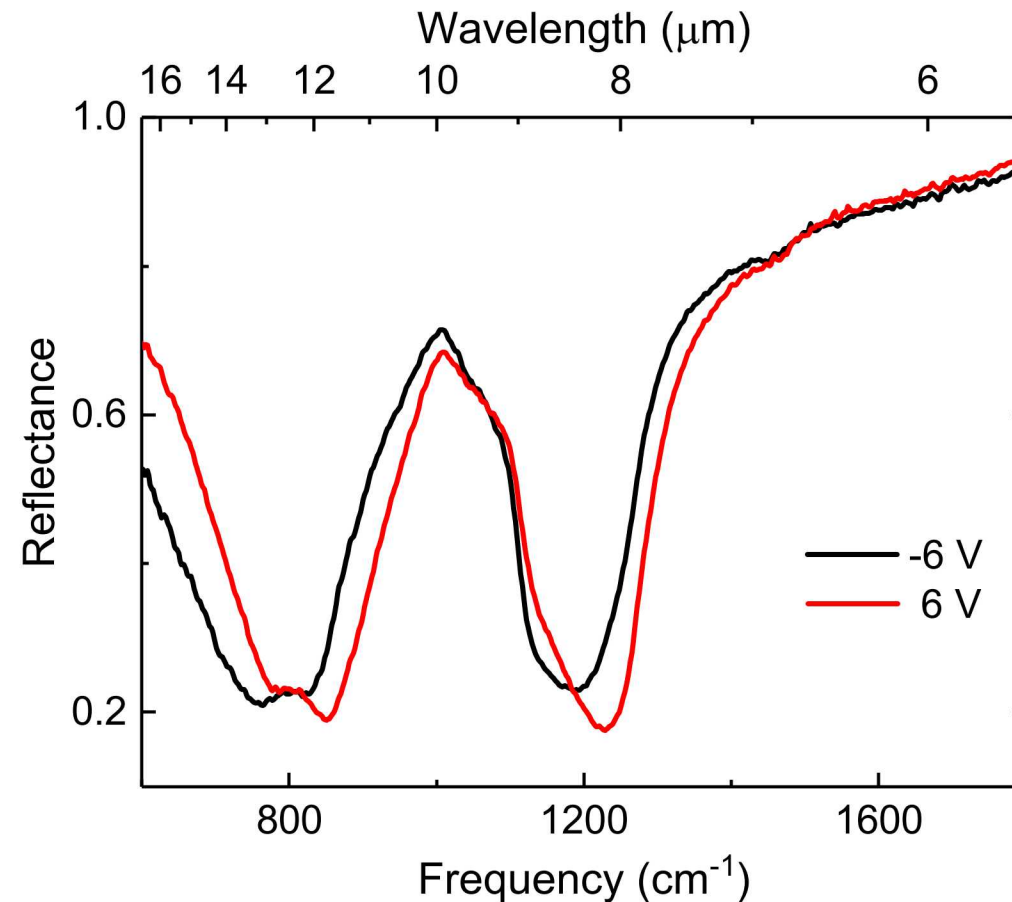
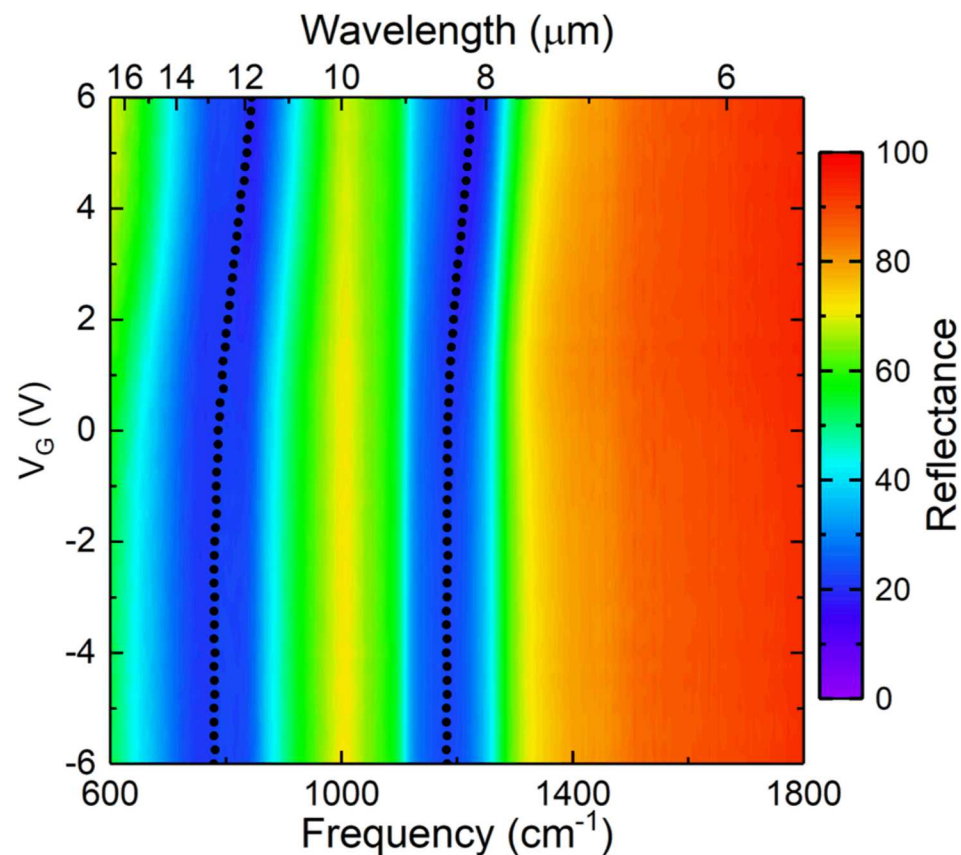
- Scalable (continuous and unpatterned large-area CVD graphene)
- Protected graphene (capping layer)
- Avoid metal-graphene contact

Building the Filter Response



- Presence of SiO₂ increases resonance Q-factors
- Dielectrics can modify resonance location.

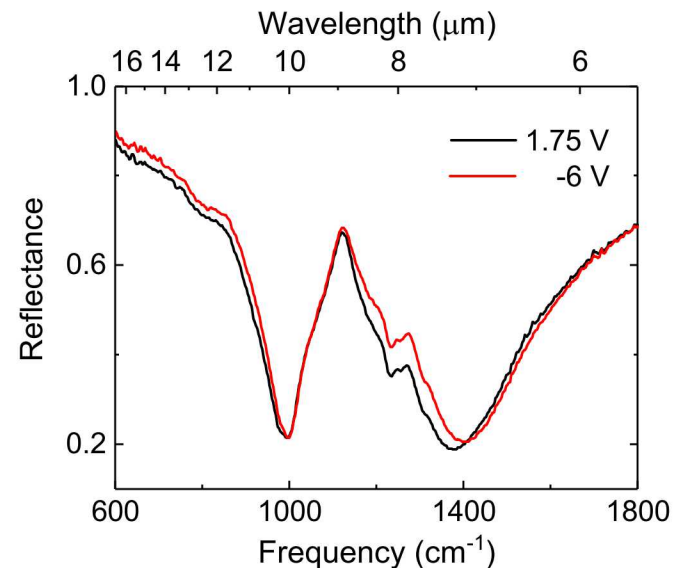
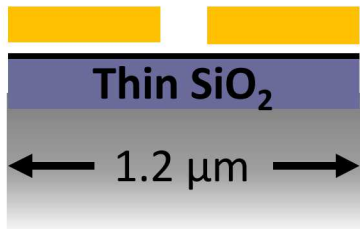
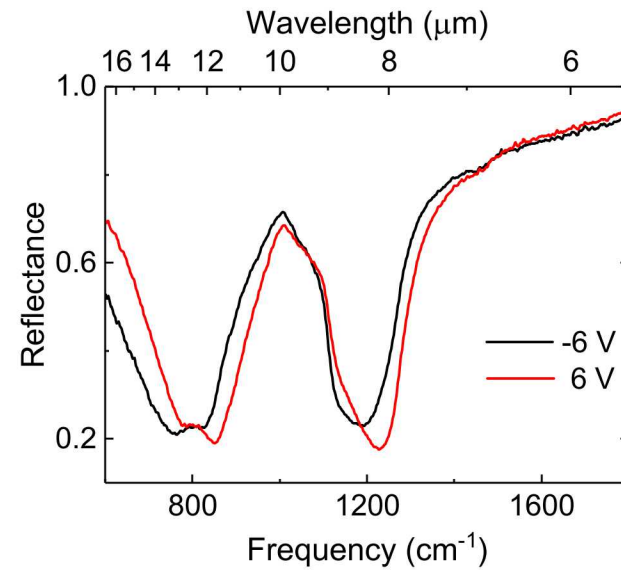
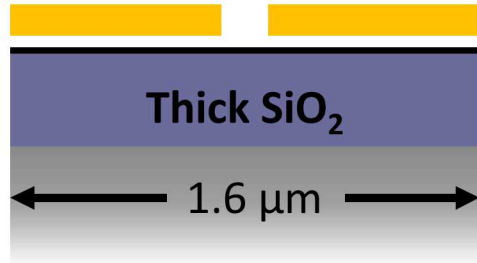
Measured Reflectance



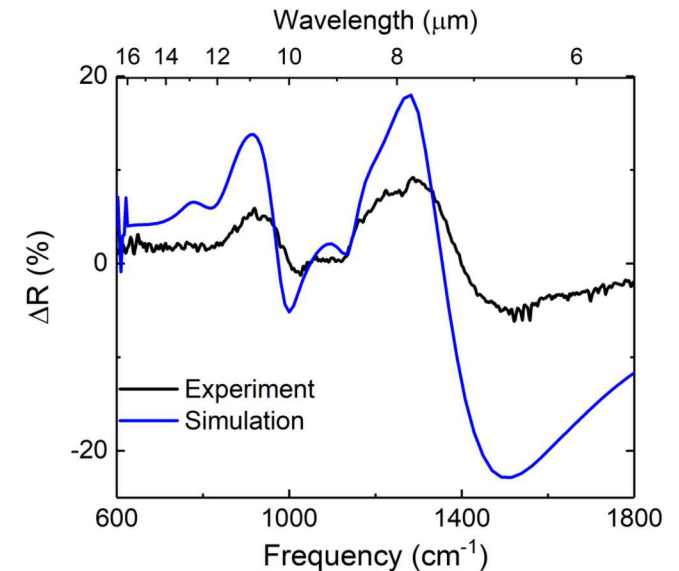
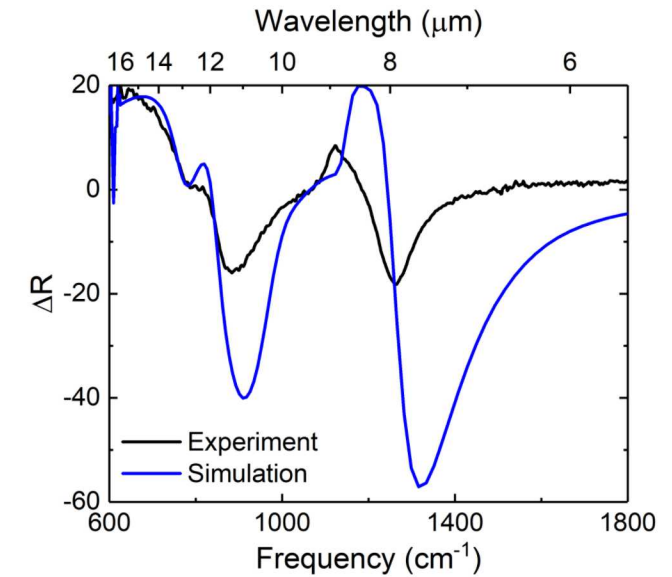
- Shift in position of two minima simultaneously.
- Larger shifts are lower frequencies.
- Spectral shift depends on both grating design and SiO₂ thickness.

Measured Reflectance

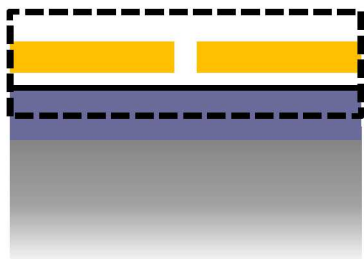
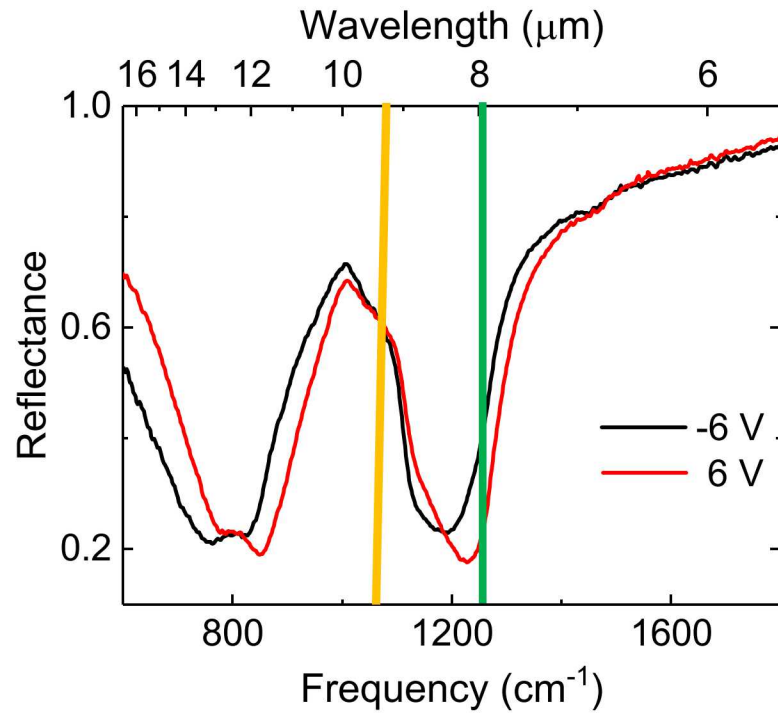
Reflectance



Reflectance Modulation

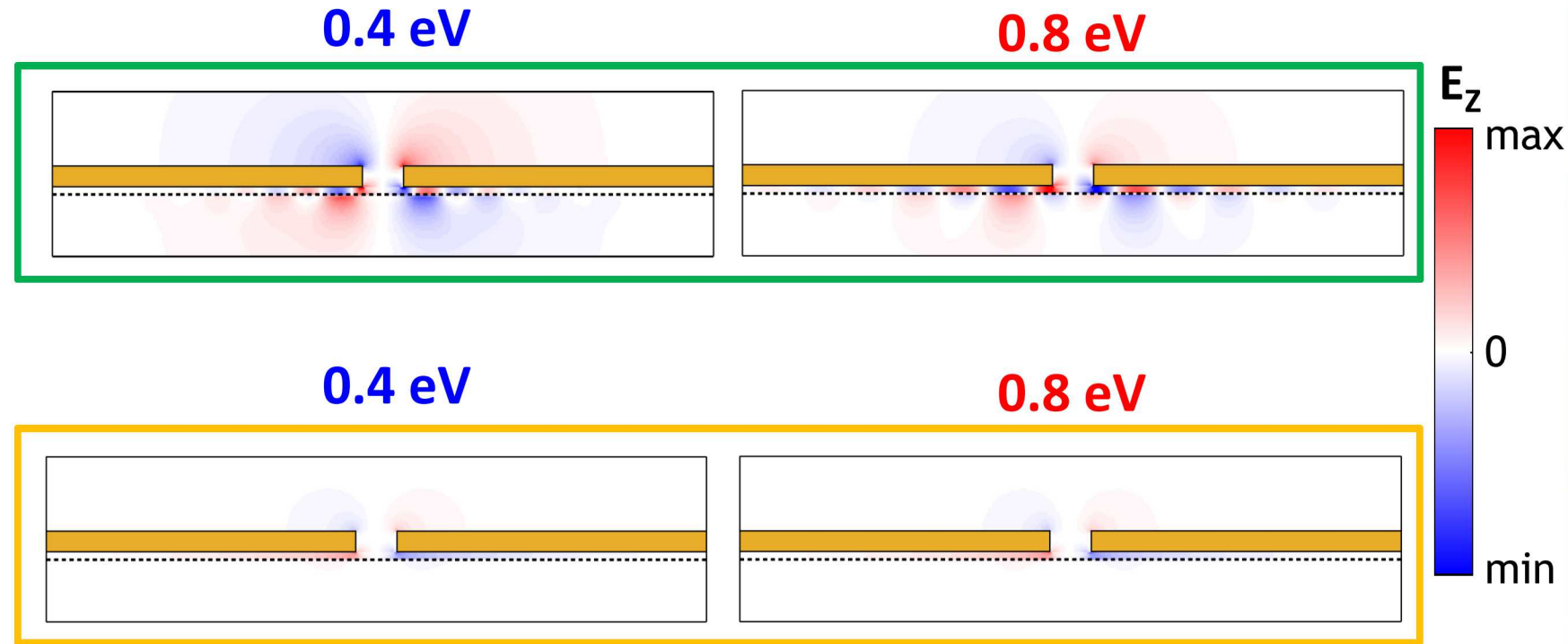


Origin of Tuning

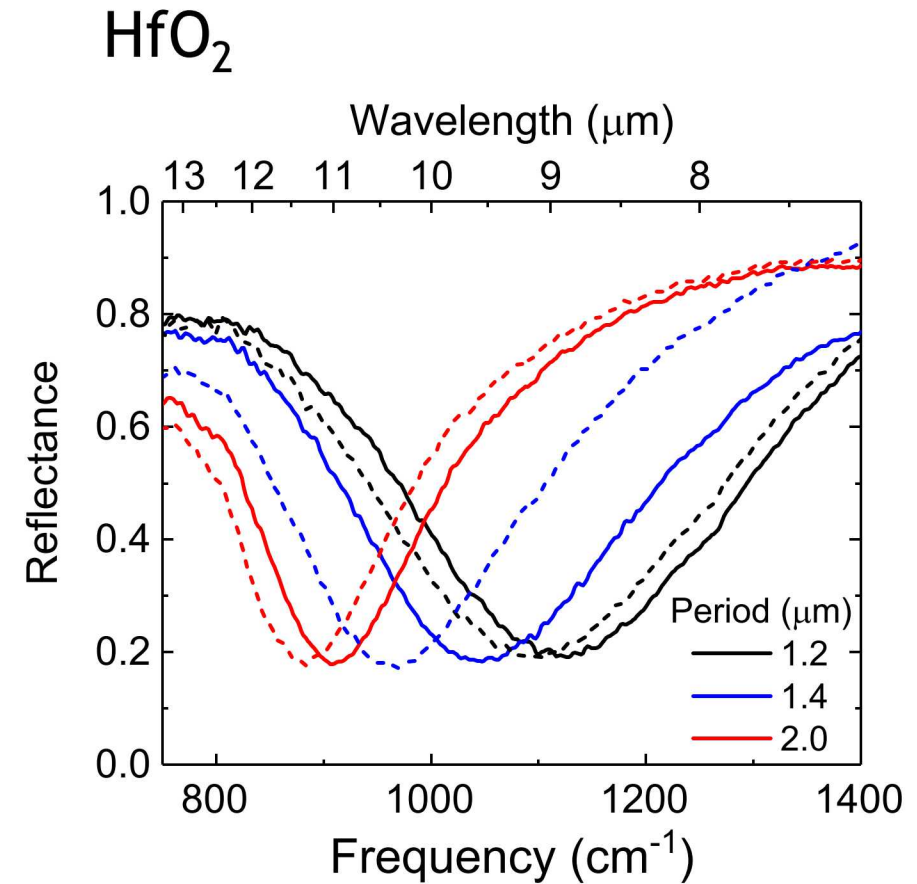
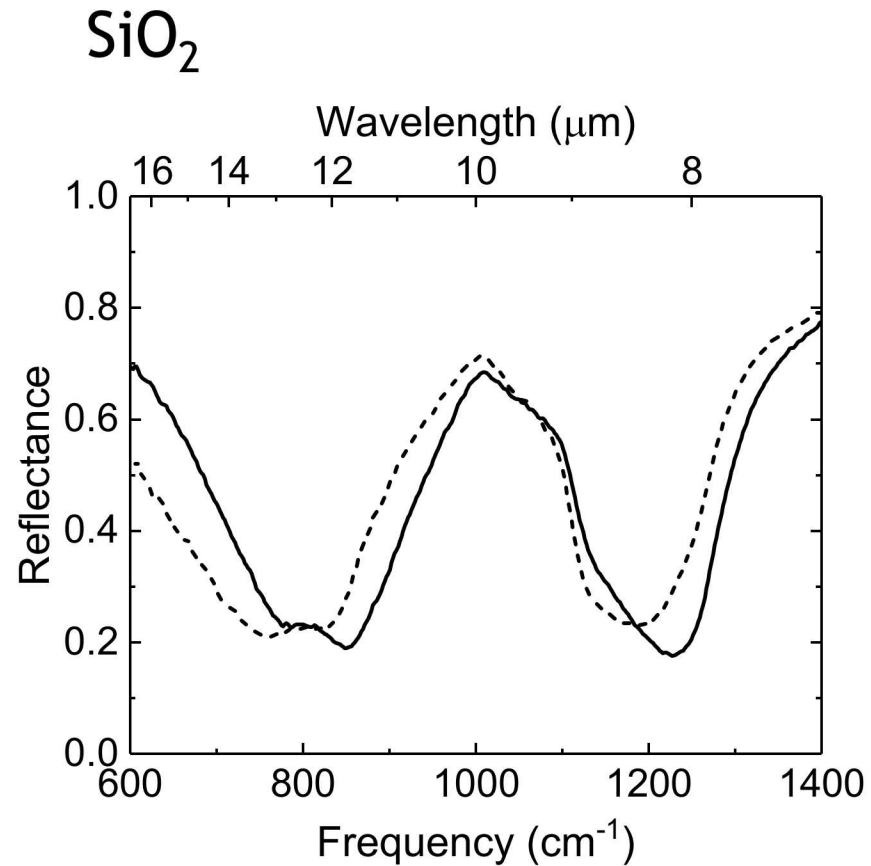


Graphene

- Tuning occurs only where plasmon is excited and modified by Fermi level.
- These regions are determined by dielectric cladding layers making them selectable.



Dielectric Modification

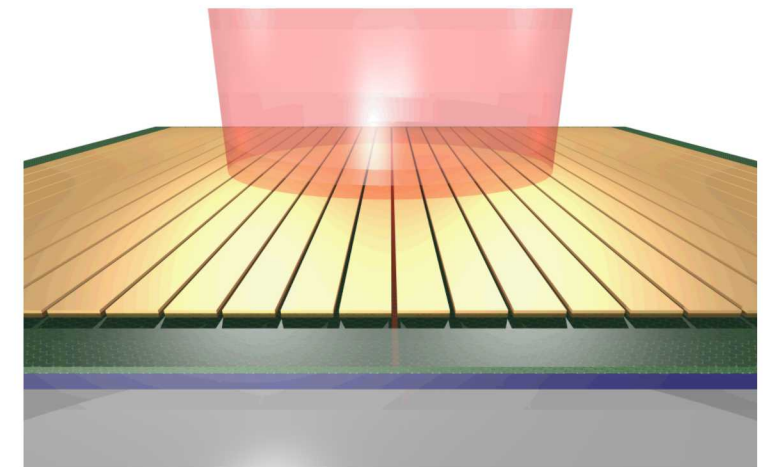
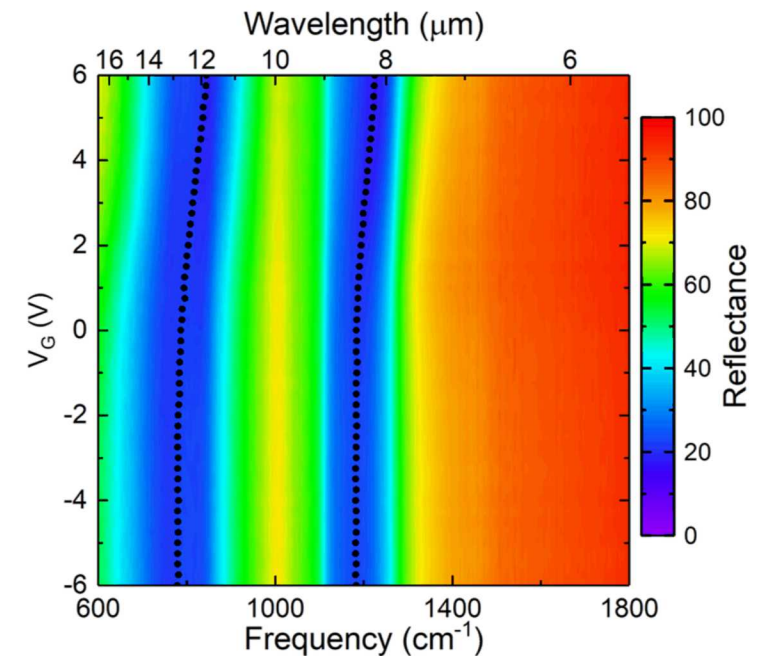
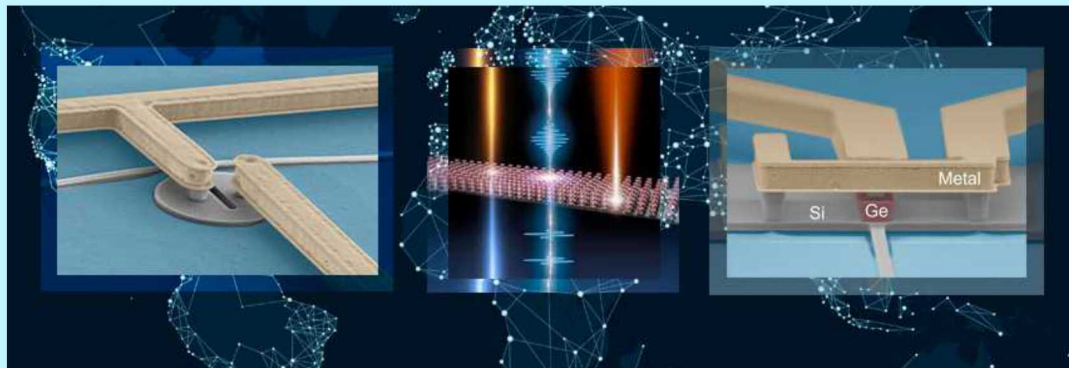


Conclusion

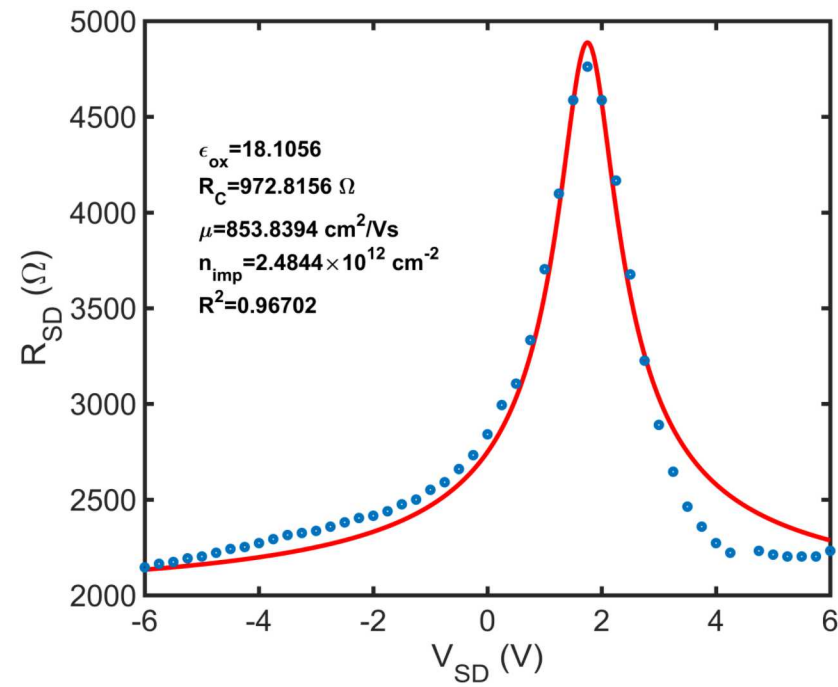
- Demonstrated scalable and tunable graphene-based IR filter.
- Enables modification of response in two bands simultaneously.
- Graphene is continuous and protected for device longevity.
- Future devices will examine alternative dielectrics and more complex geometries.

Sandia's National Security Photonics Center (NSPC)

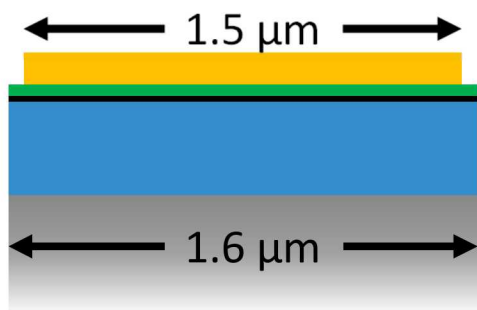
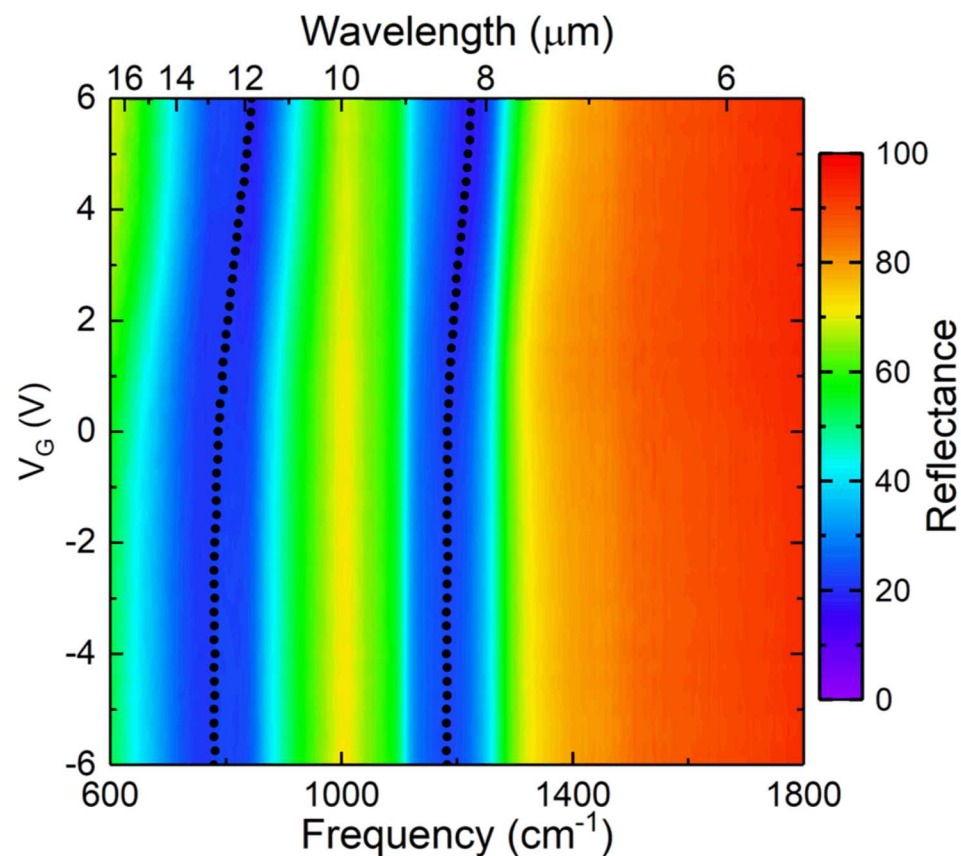
<http://www.sandia.gov/mstc/nspc/>



Transport Data



Measured Reflectance



- Spectral shift depends on both grating design and SiO₂ thickness.
- Shift in position of two resonances simultaneously.
- Larger shifts are lower frequencies.

