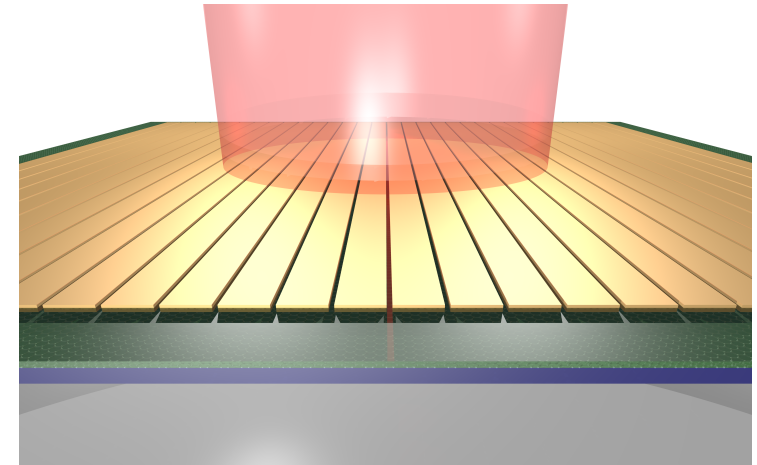
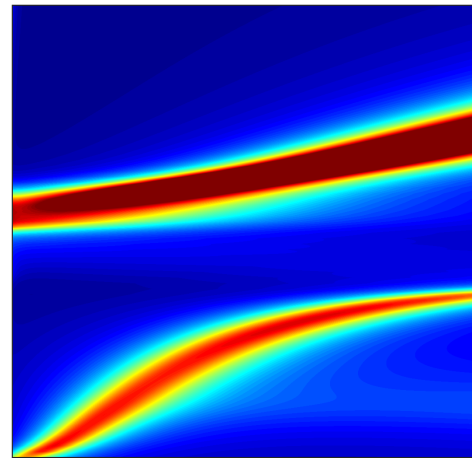
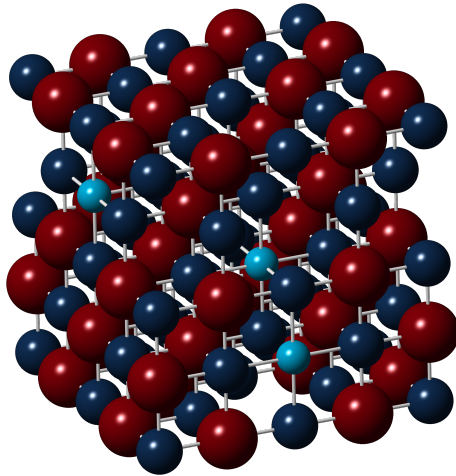


Exceptional service in the national interest



Dopant Incorporation in Cadmium Oxide for Plasmonic Applications

Thomas Beechem

Google Scholar: <http://goo.gl/96jGNv>

Team:

Chris Saltonstall

Anthony McDonald

Jon Ihlefeld

NC STATE
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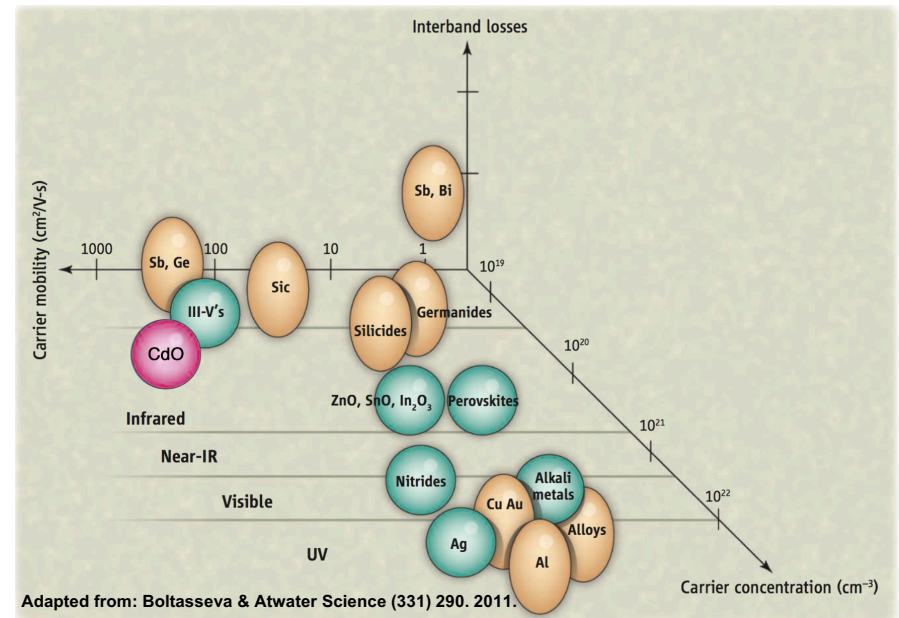
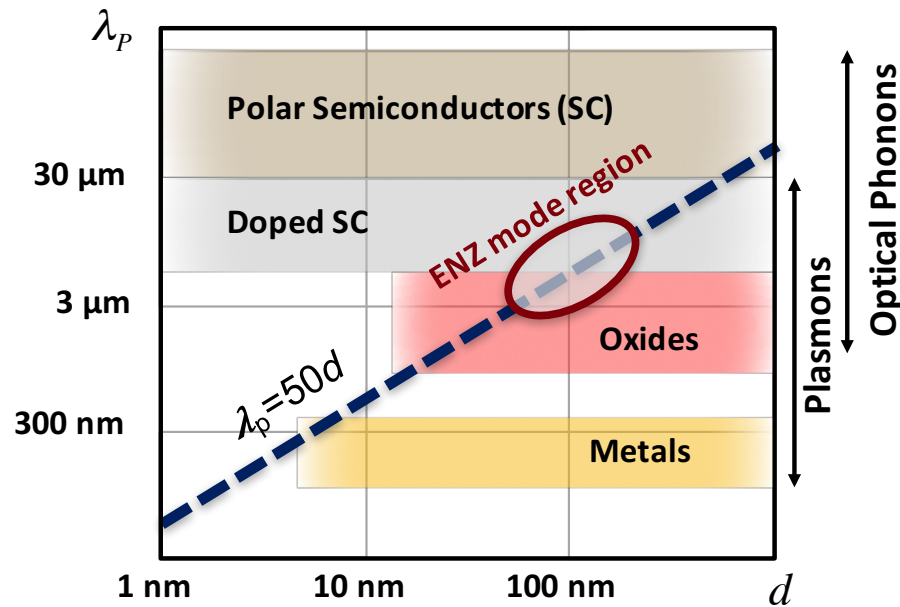
Evan Runnerstrom

Jon-Paul Maria



CdO for LWIR Plasmonic Devices

PREMISE: CdO's combination of mobility & λ_p promising for LWIR



Goals

Raman "Hall Measurements"

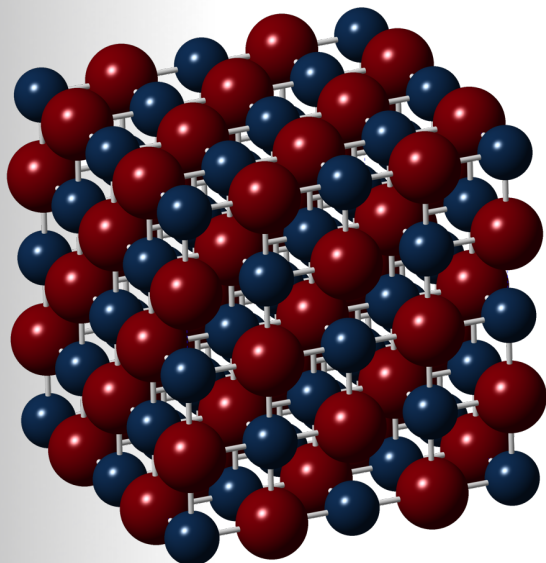
Field Induced Coupling

Plasmonic Implications

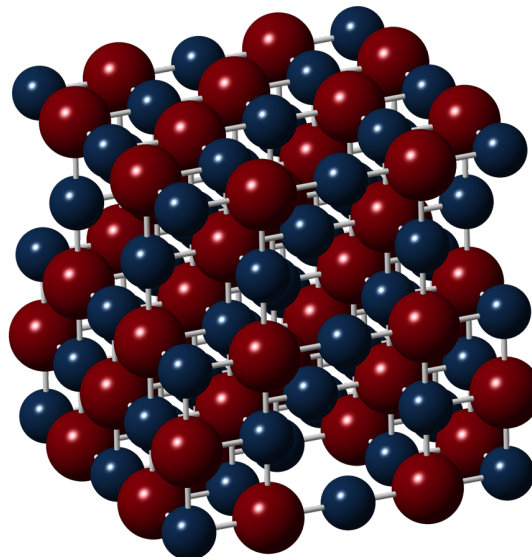
Vanadium Doped CdO

Doping in CdO

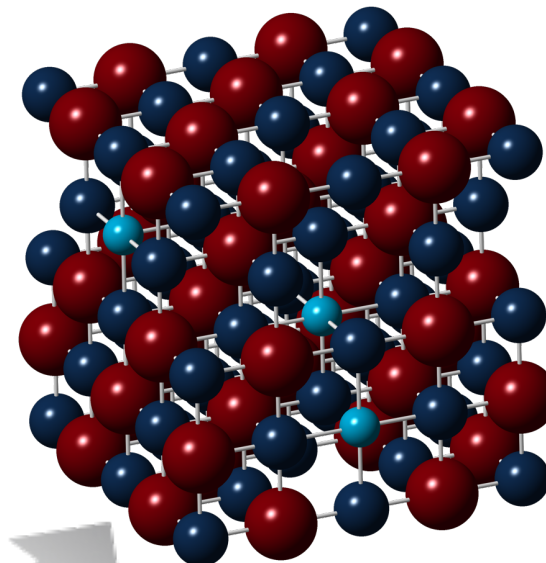
No Vacancies, No Charge



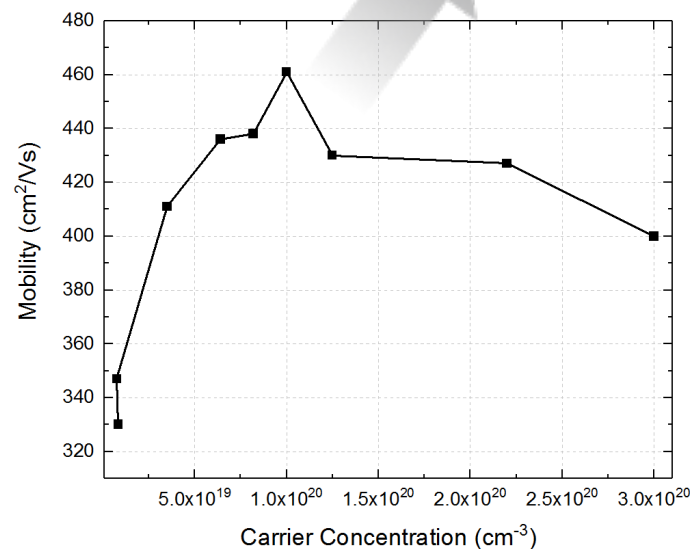
Vacancy Doping $\downarrow \mu$



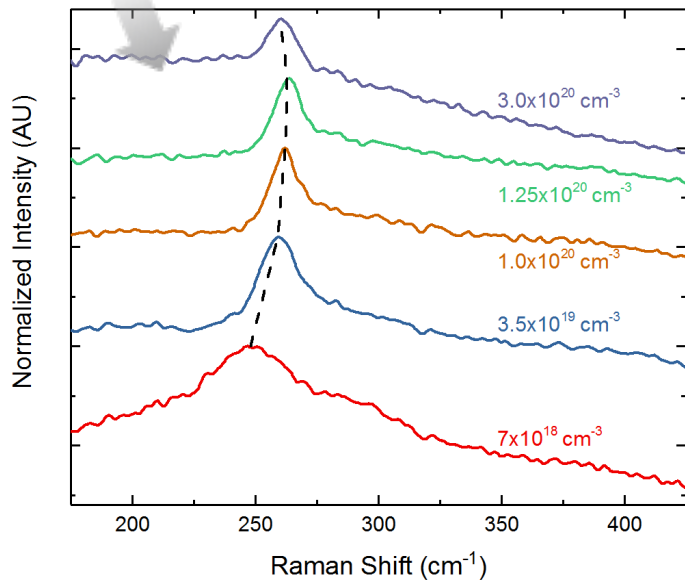
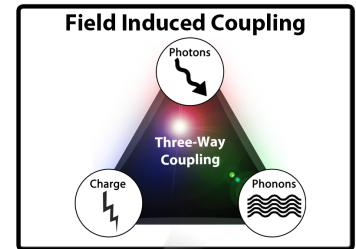
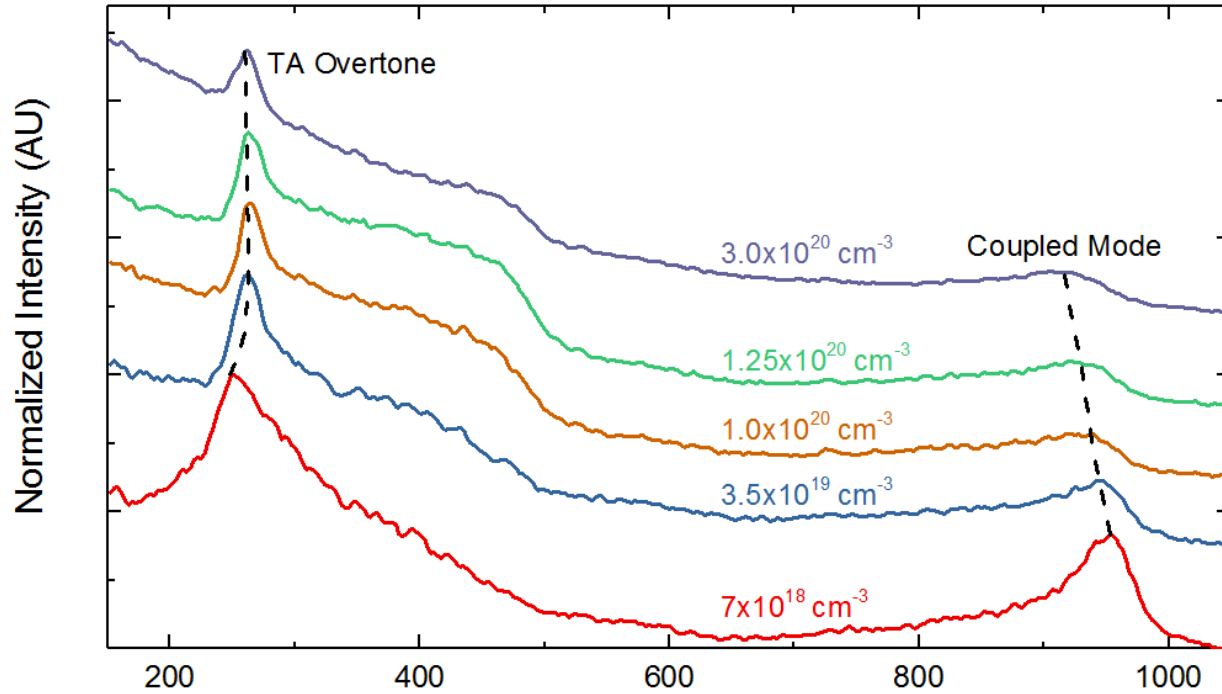
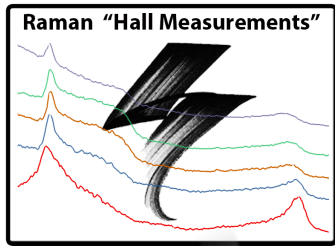
Vanadium Doping $\uparrow \mu$



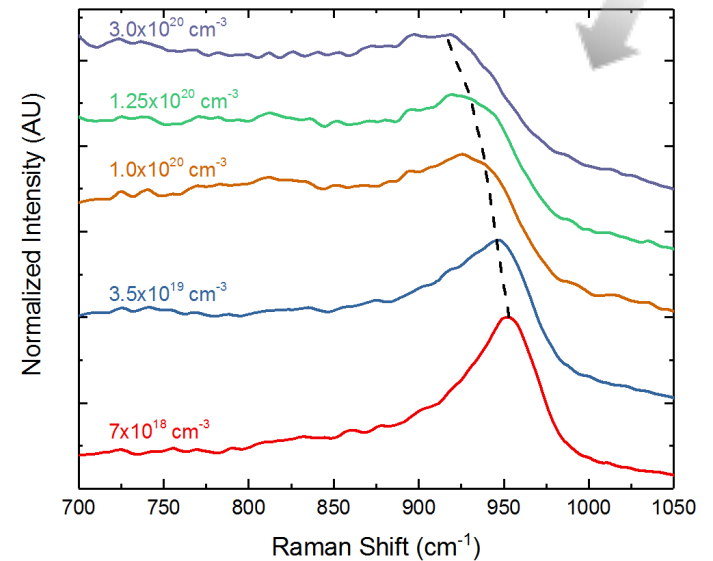
Question:
Can Raman “see” the doping?



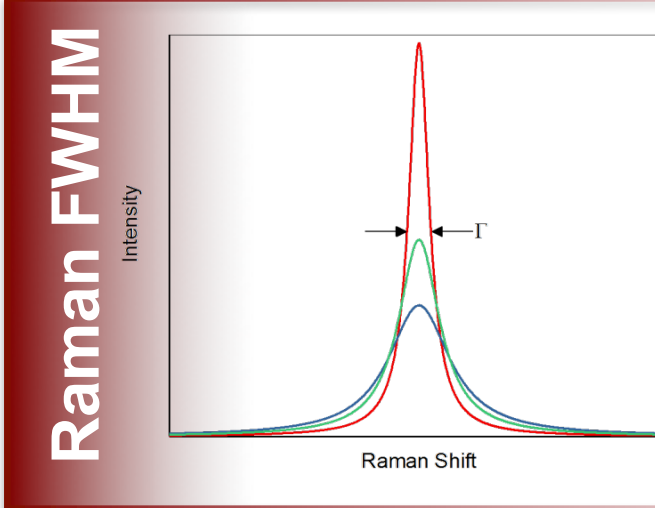
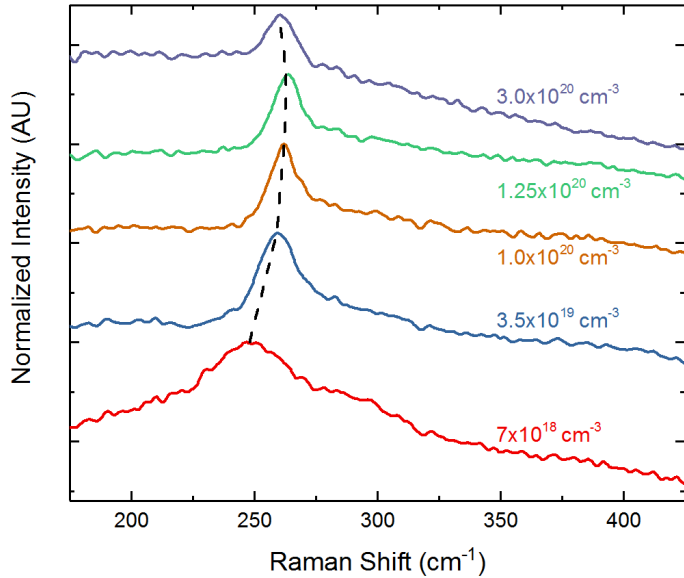
Two Modes: Different Physics



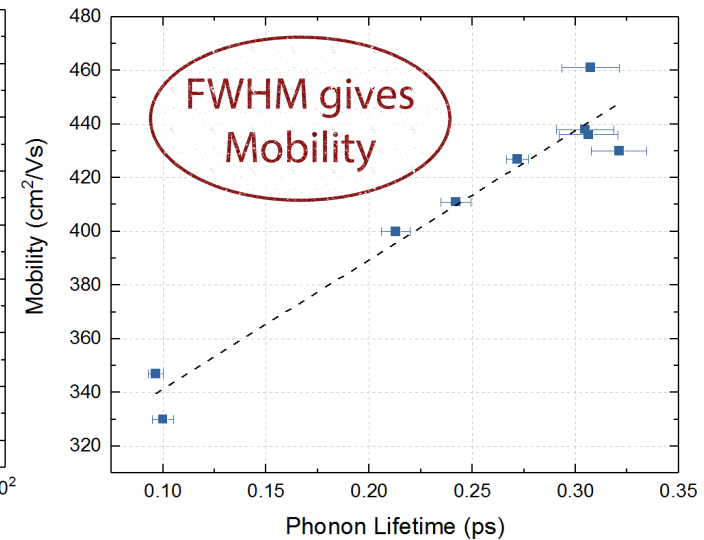
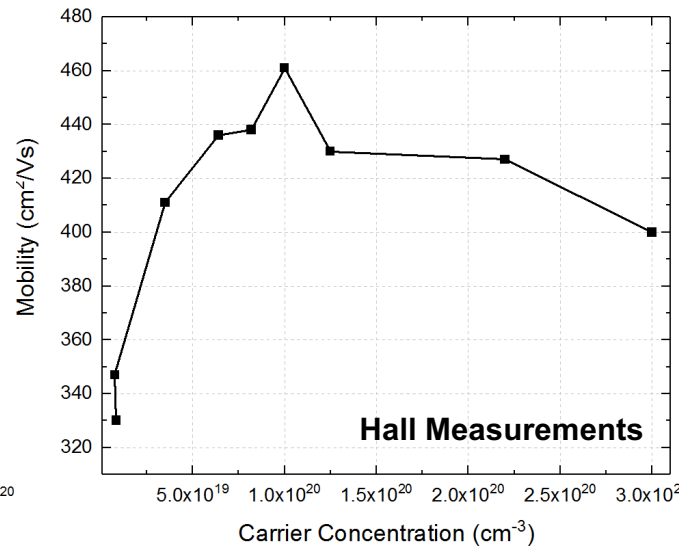
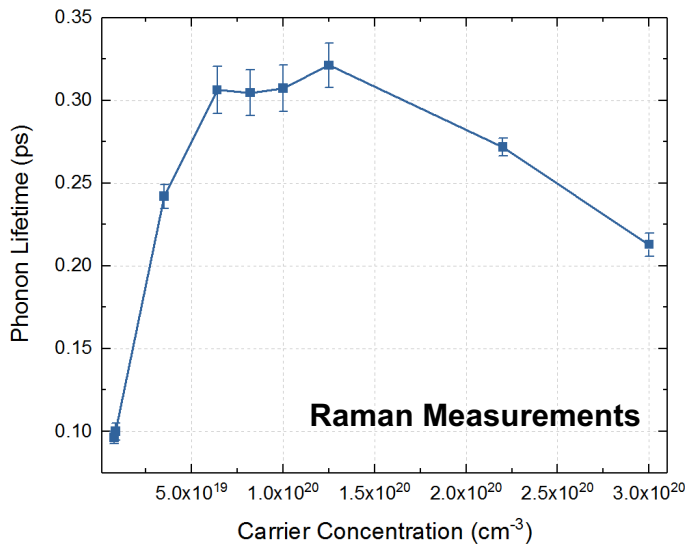
Raman Shift (cm^{-1})



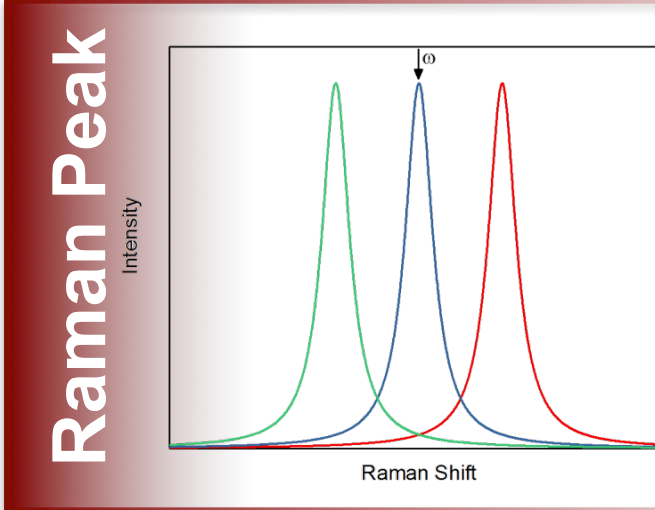
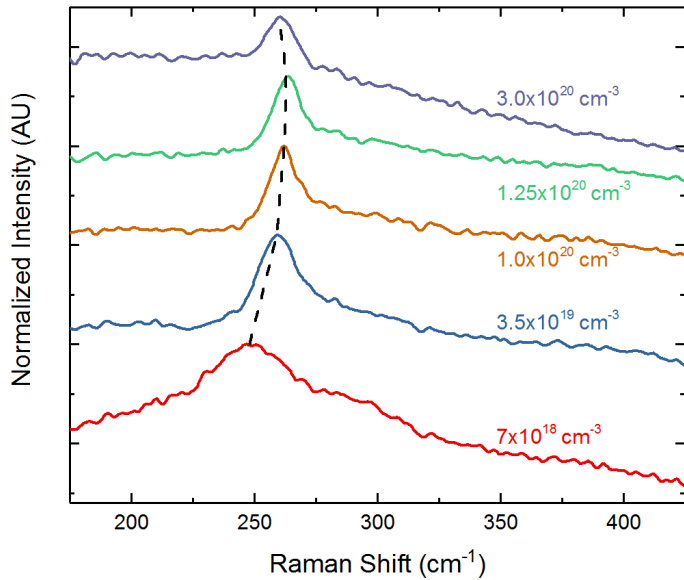
Raman “Hall Measurements”



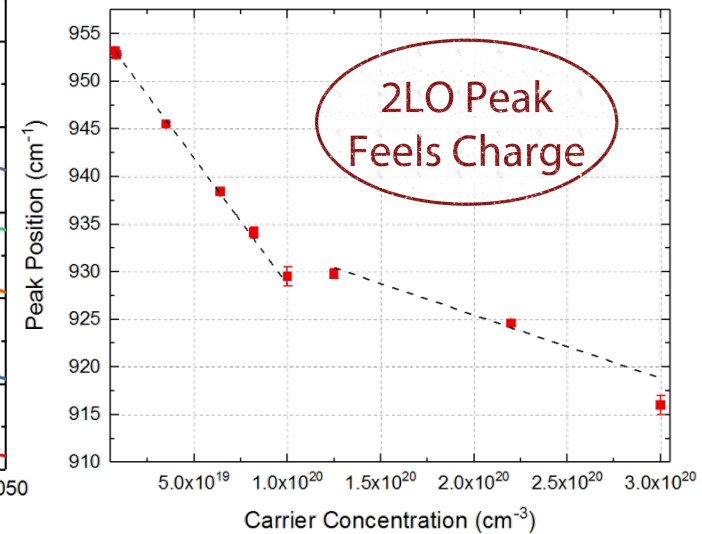
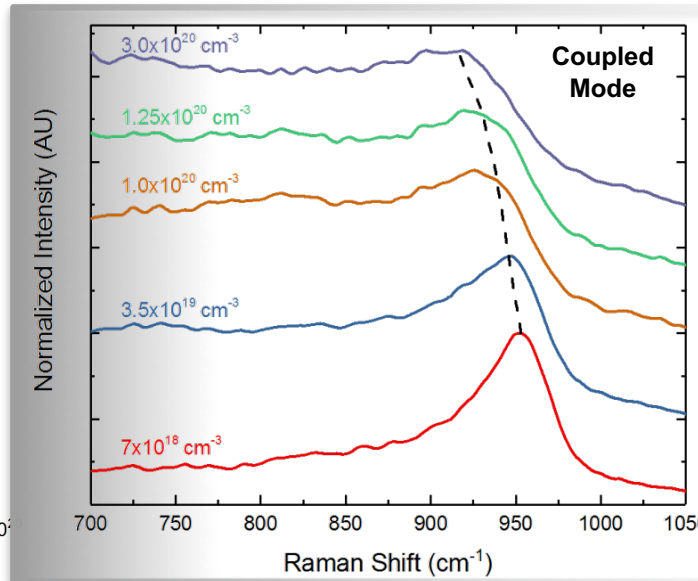
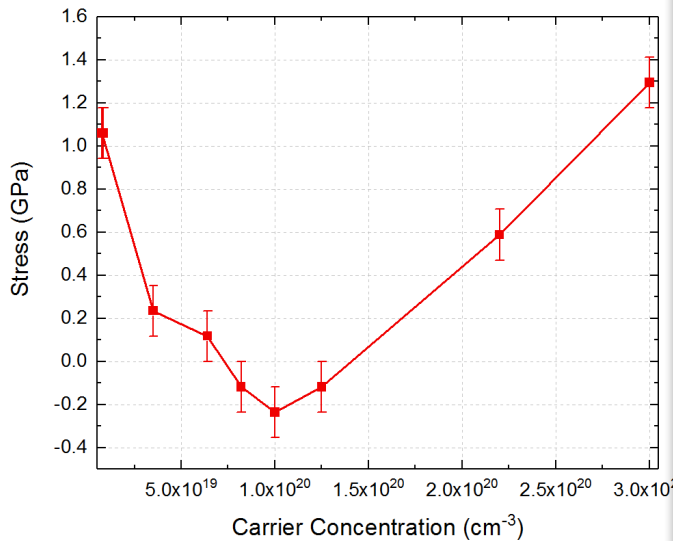
- Peak width linked to phonon lifetime
- Lower phonon lifetime more scattering
- More scattering → Lower mobility



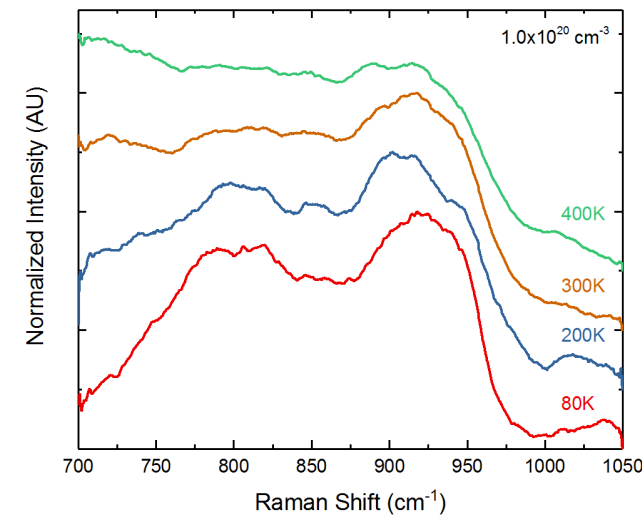
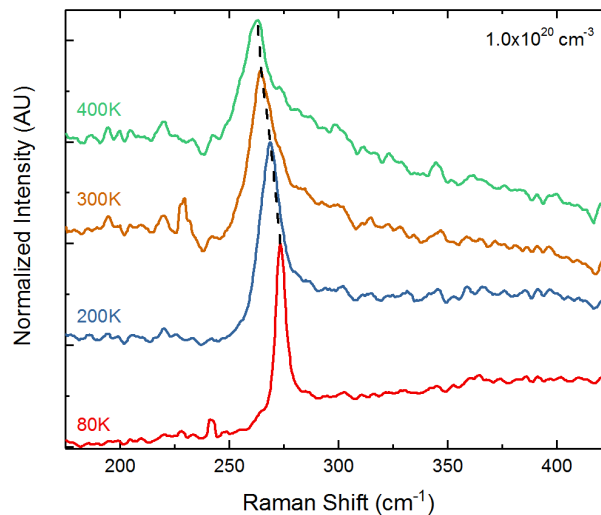
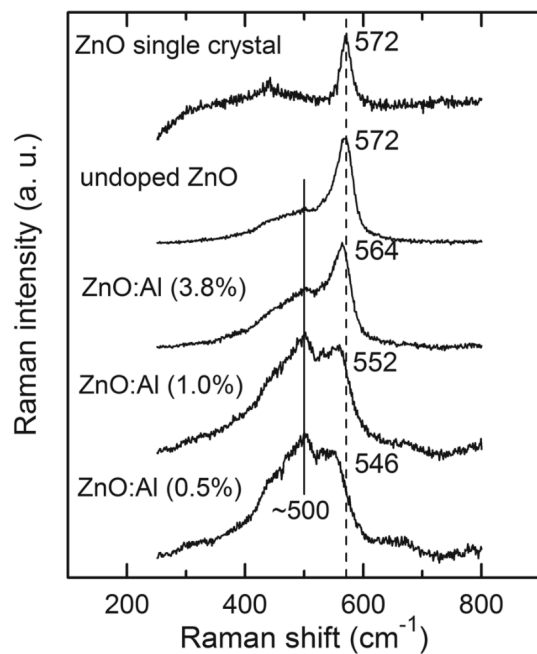
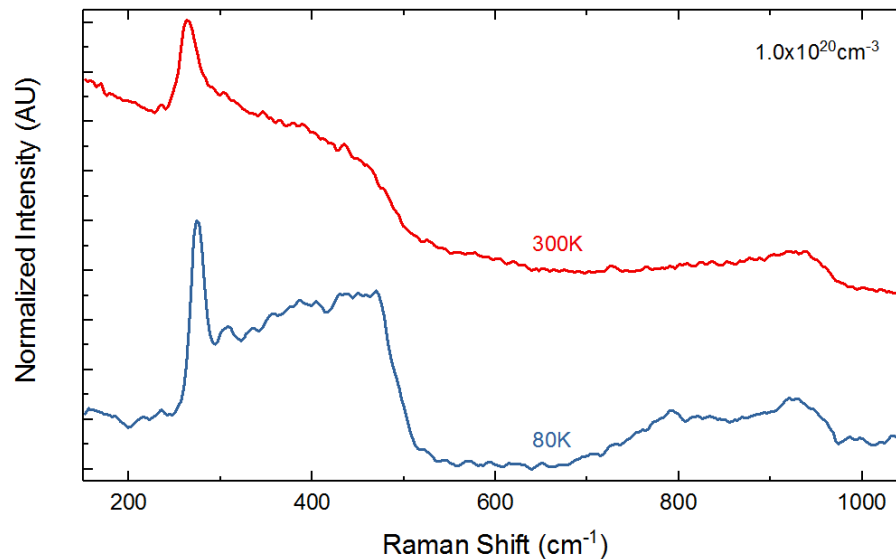
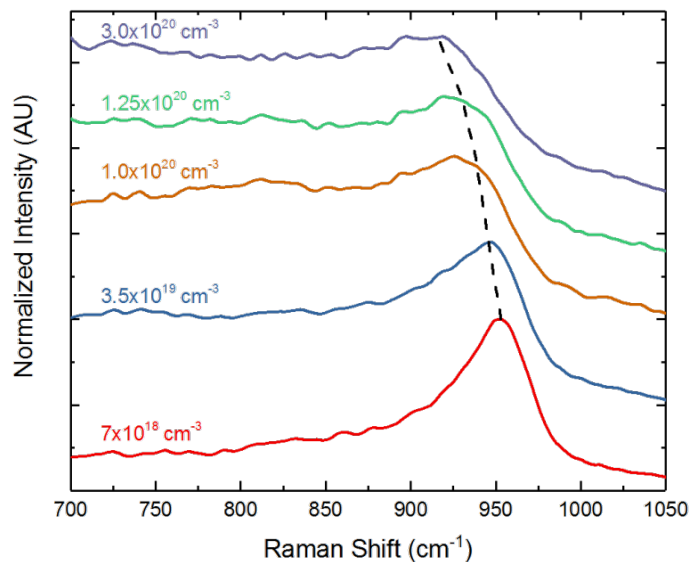
Raman “Hall Measurements”



- Peak position most often dominated by strain
- Used to measure temperature or stress
- Sometimes linked to charge environment

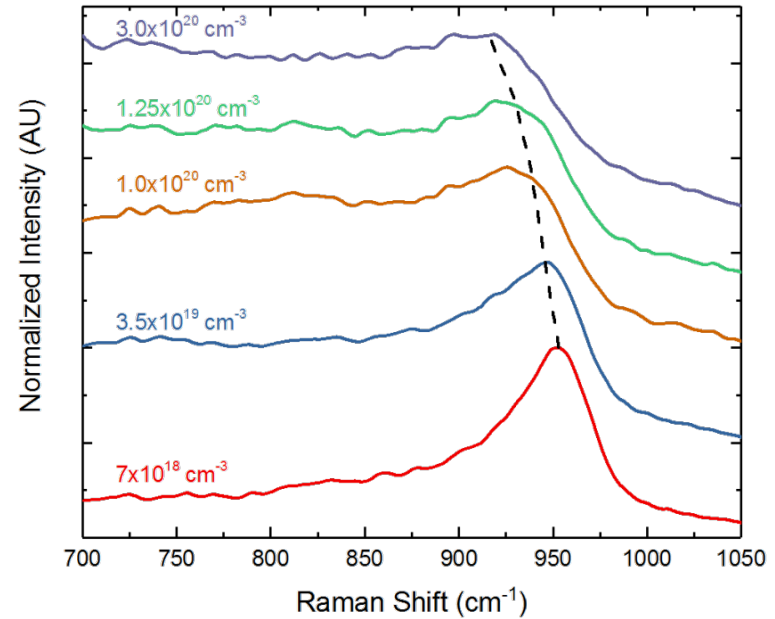
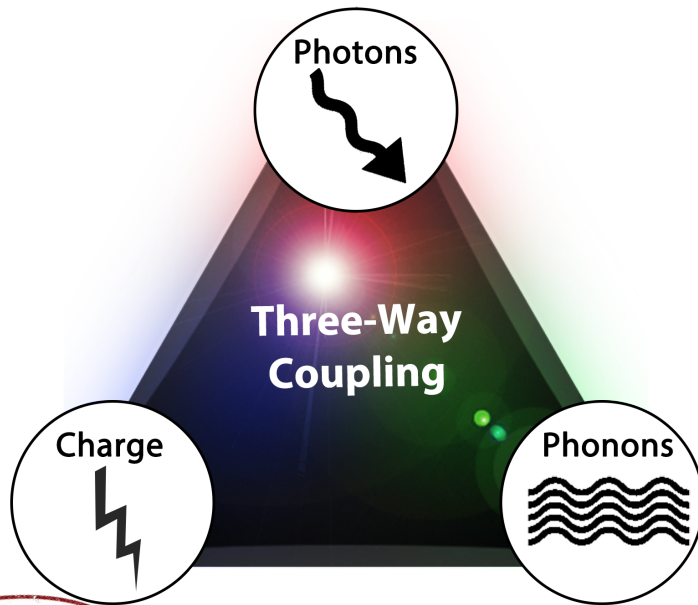


Coupled Mode



They're coupled...so what?

Impact on Dielectric Constant



Raman Lineshape

$$I_R \propto \int_0^{q_{max}} F(q) S(q, \omega) \Im \left[-\frac{1}{\epsilon(q, \omega)} \right] dq$$

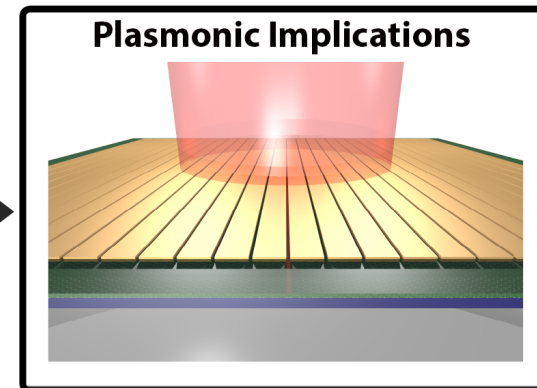
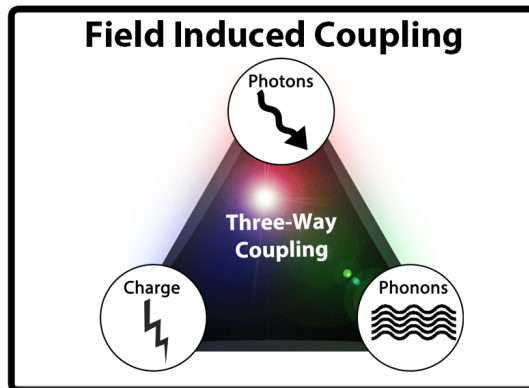
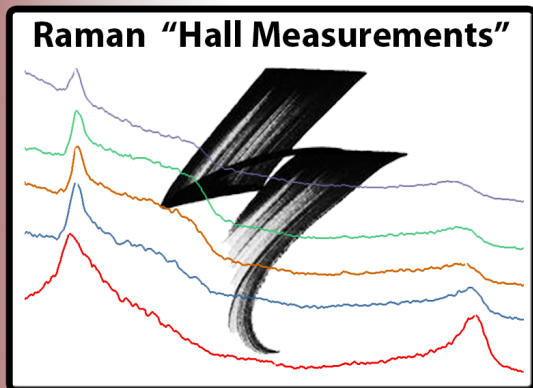
Implication

- Light of differing wavevectors “sees” different dielectric constant.
- Possibility: Wavevector tuning of plasmonic device

Lindhard-Mermin Approximation

Take Home Message

Goals



Takeaways

1. Raman determines mobility & carrier concentration in CdO
2. Momentum dependent dielectric constant identified by coupled mode
3. Suggests wavevector tuning of CdO plasmonic devices

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tebeech@sandia.gov