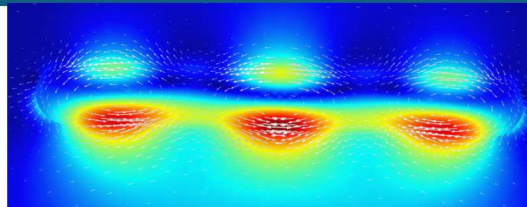
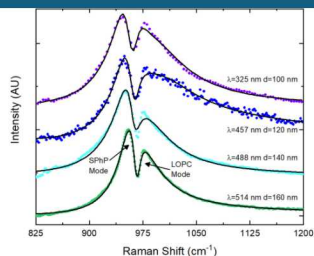
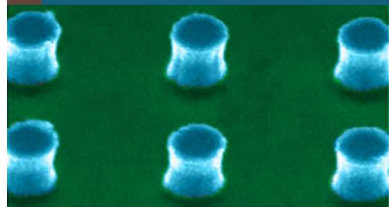
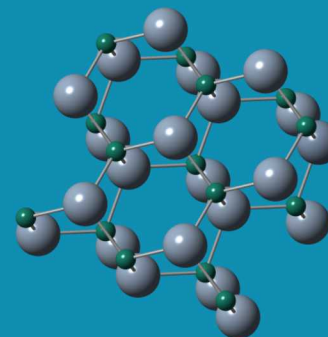




SAND2019-0839C

Leveraging Momentum for Increased Tuning of Phonon-Polariton Metasurfaces



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Team

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VANDERBILT UNIVERSITY

U.S. NAVAL
RESEARCH
LABORATORY



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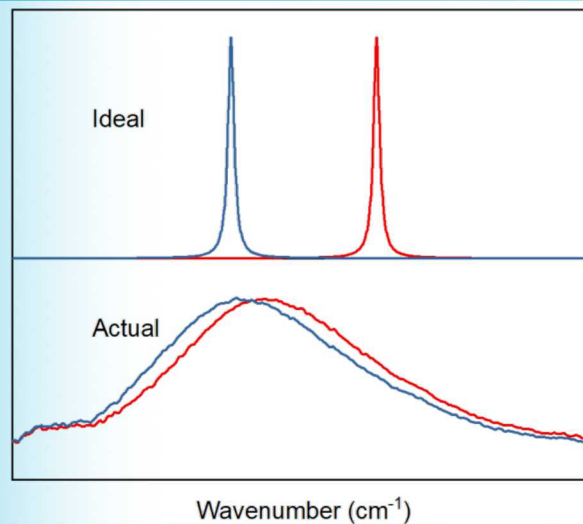
Vision: Dynamic Multi-Functional IR Sensing



Imagine



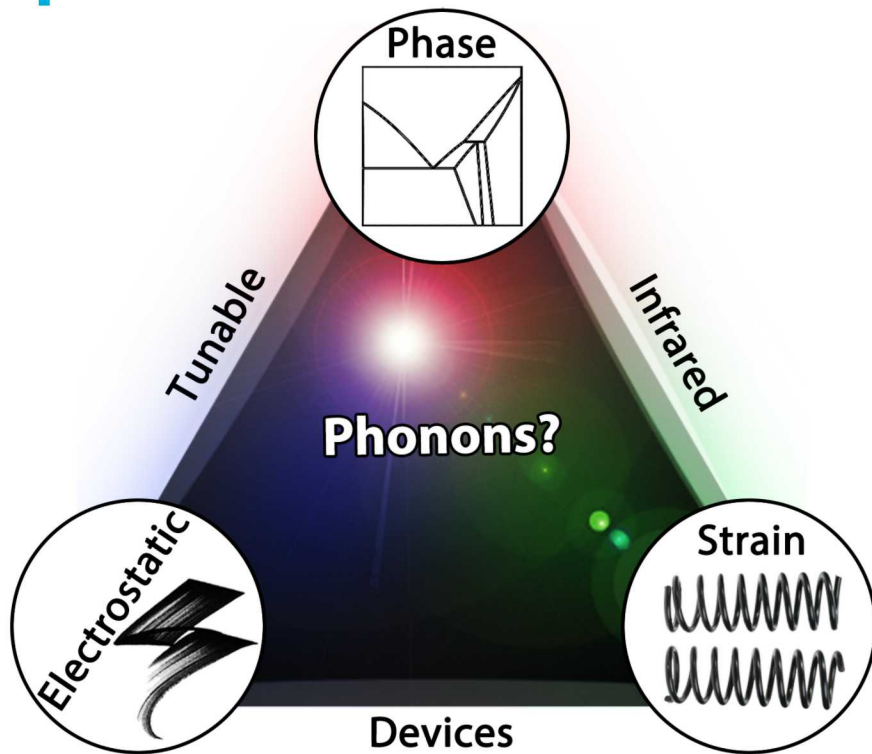
Right Now



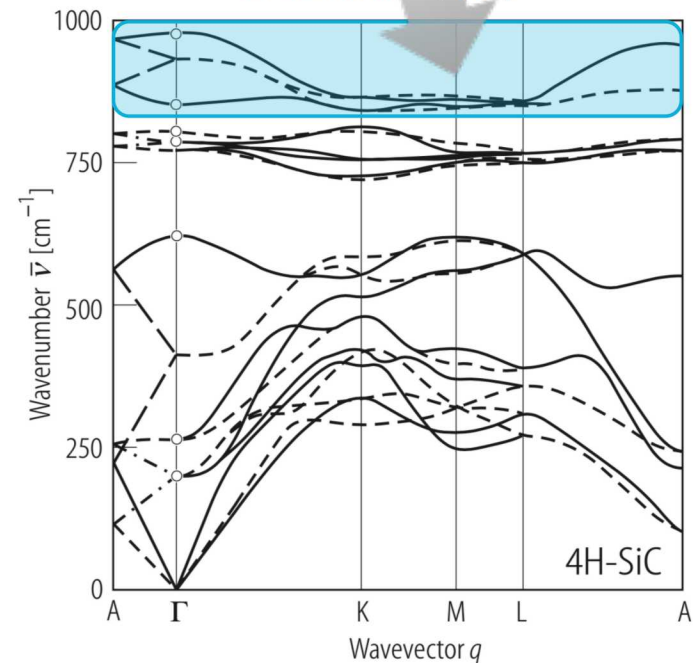
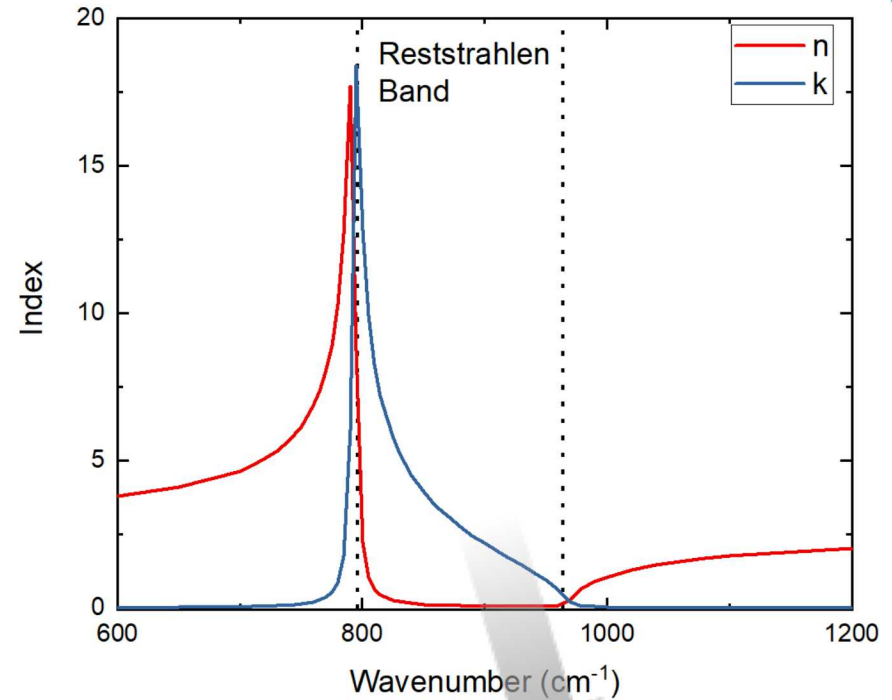
Problems:

1. Filters not “narrow” enough
2. Filters don’t “tune” enough

Idea: Phonons for Infrared Optics



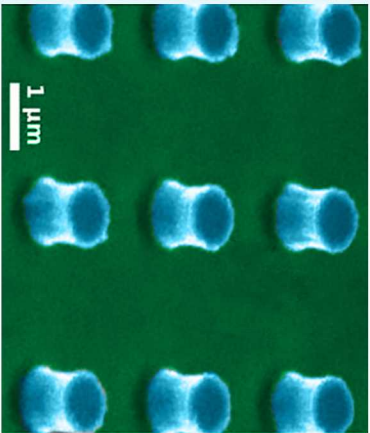
Impact IR ✓
Narrow ✓
Tune ?



Approach: Make, Measure, Think



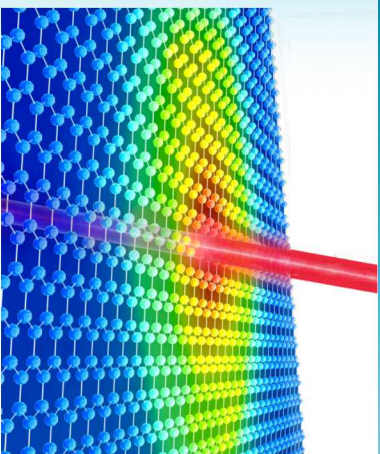
Make



Sample: 4H-SiC Nanopillars

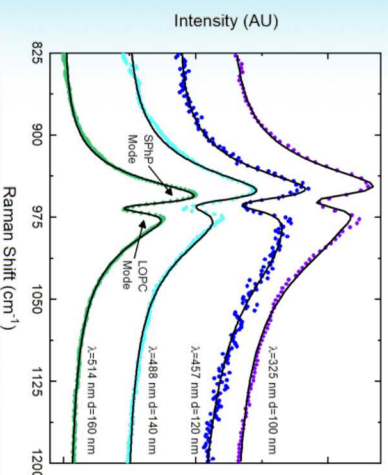
Variables: Nanopillar diameter, Laser wavelength

Measure



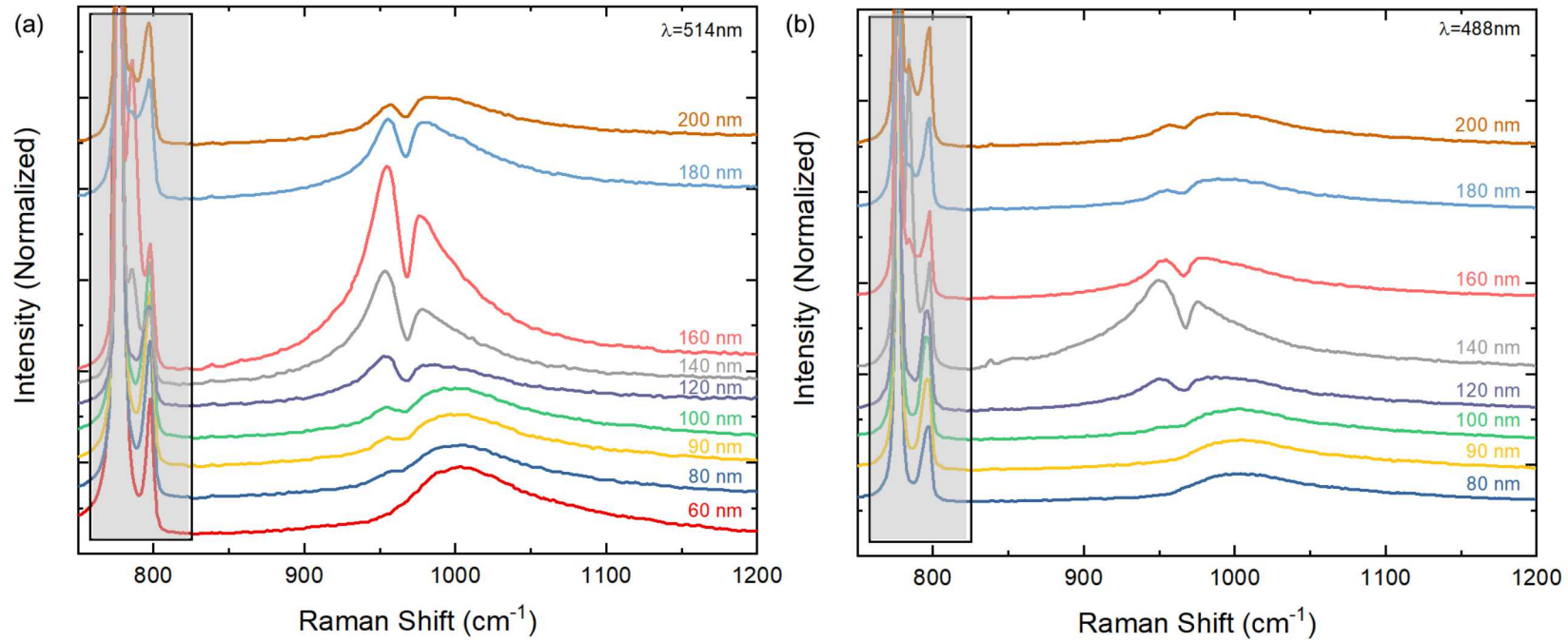
Tools: Raman, FTIR, &
UV-Vis spectroscopy

Think

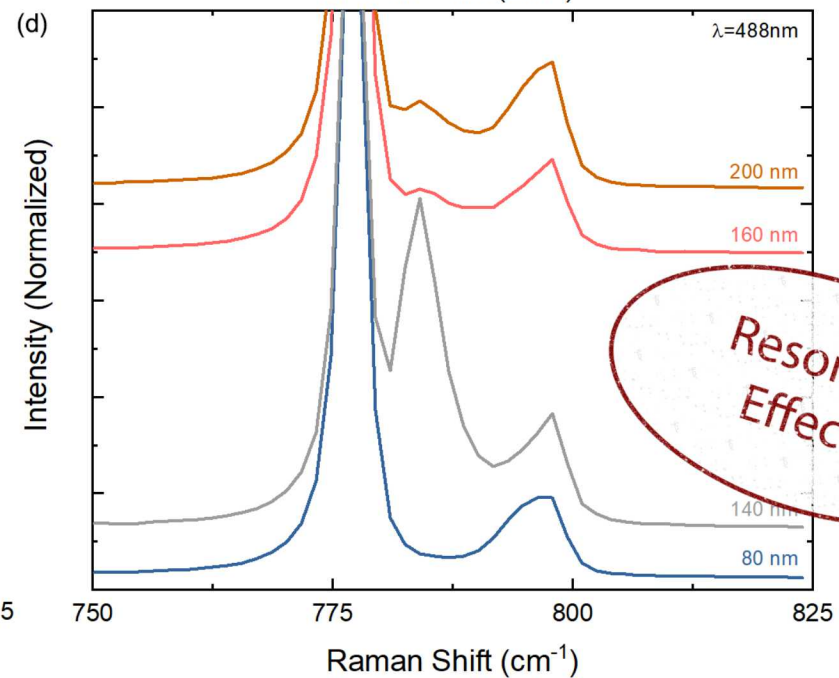
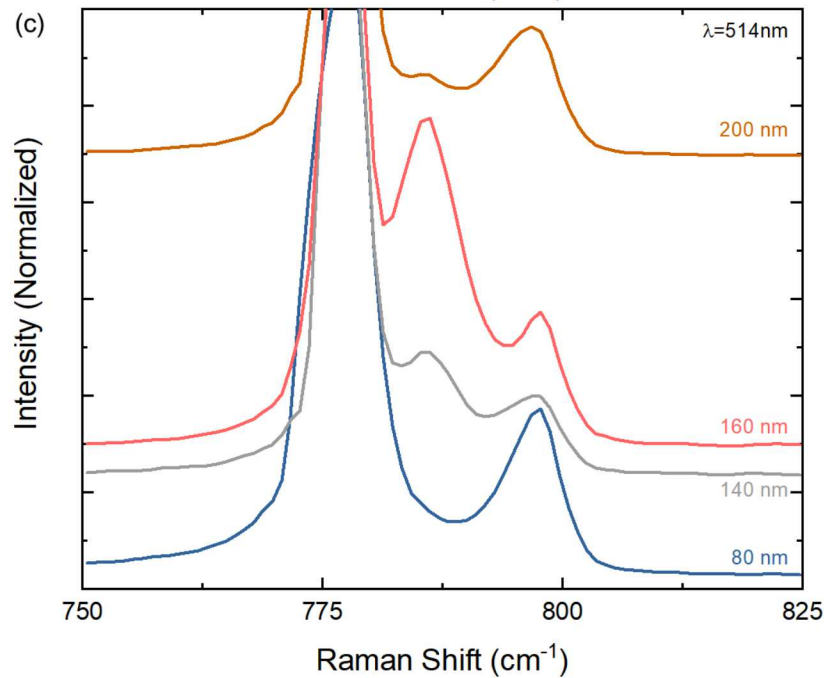
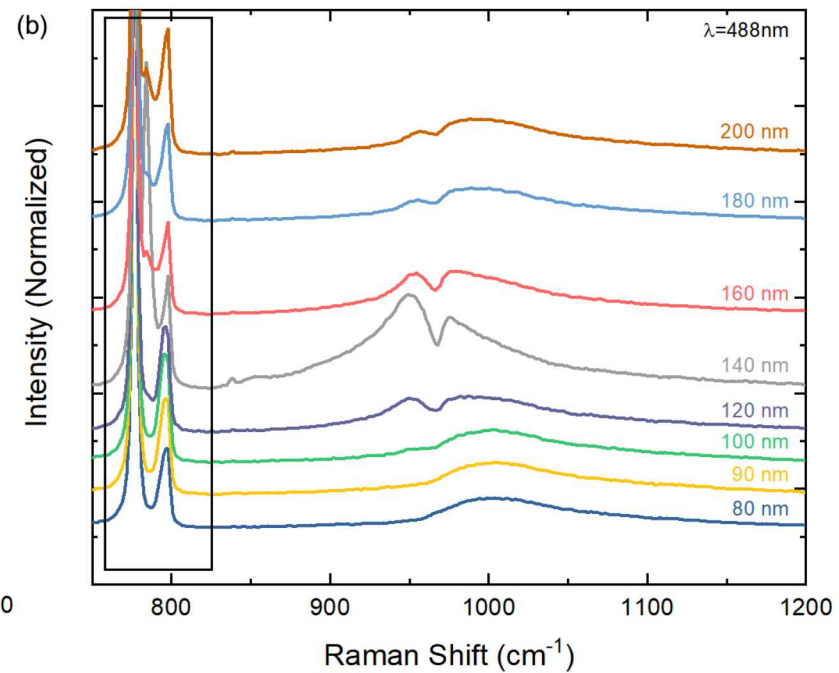
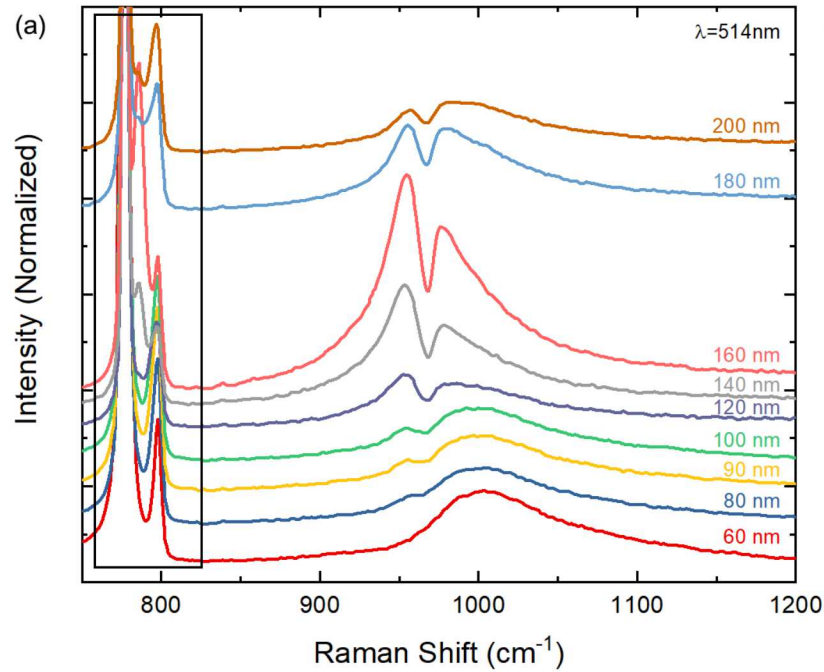


Approach:
Deduce scattering paths
from spectroscopic
fitting

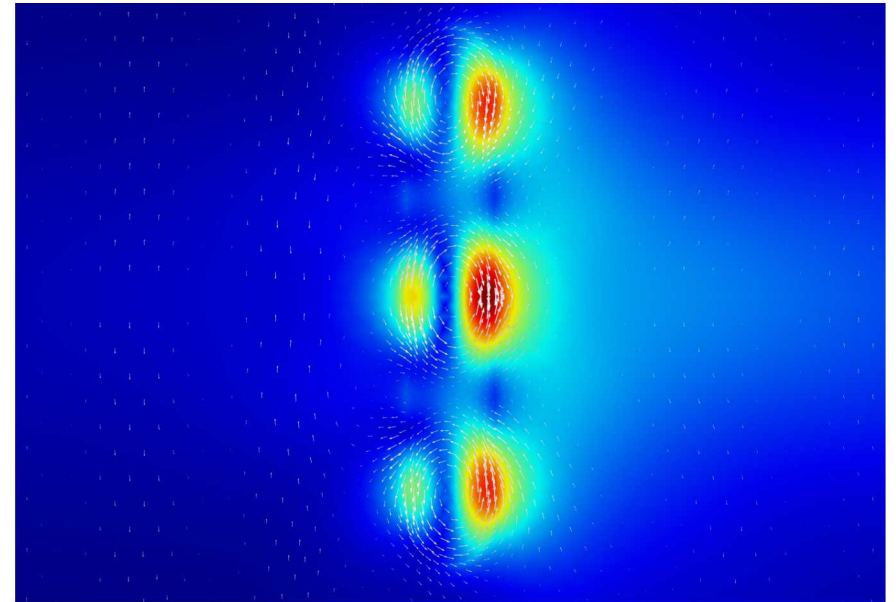
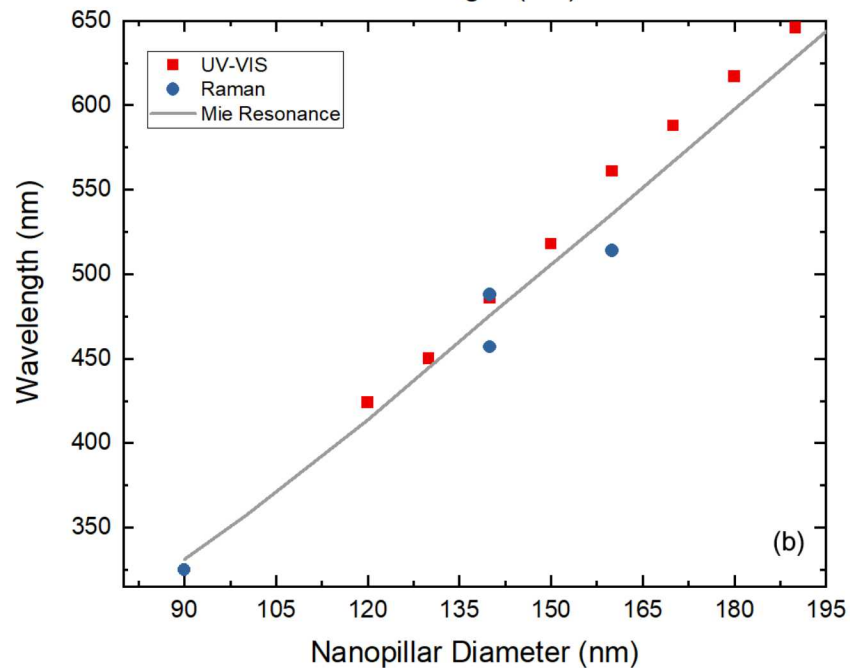
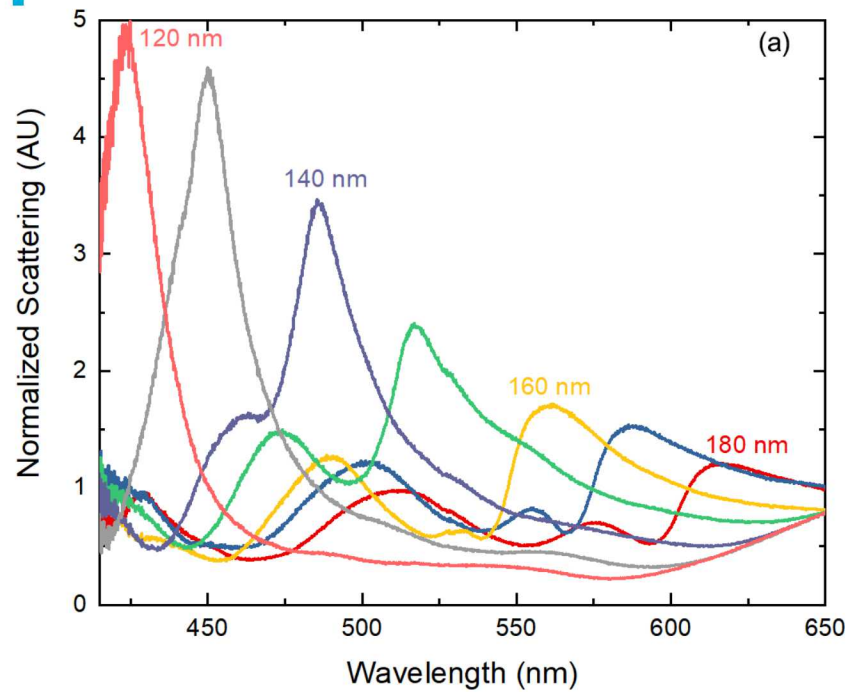
A Wavelength & Diameter Dependence



A Wavelength & Diameter Dependence



The Mie Resonance



What's Raman
got to do with
Mie?



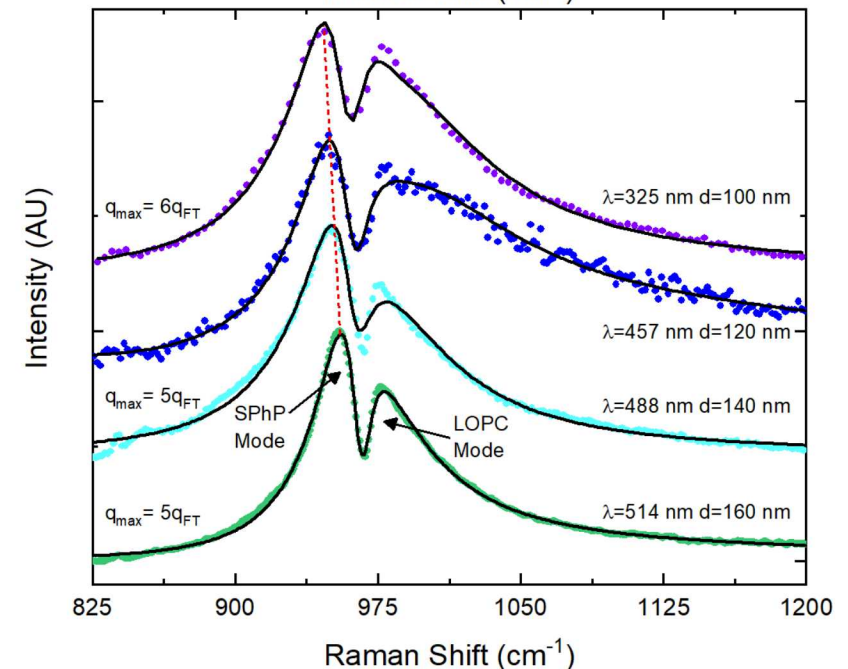
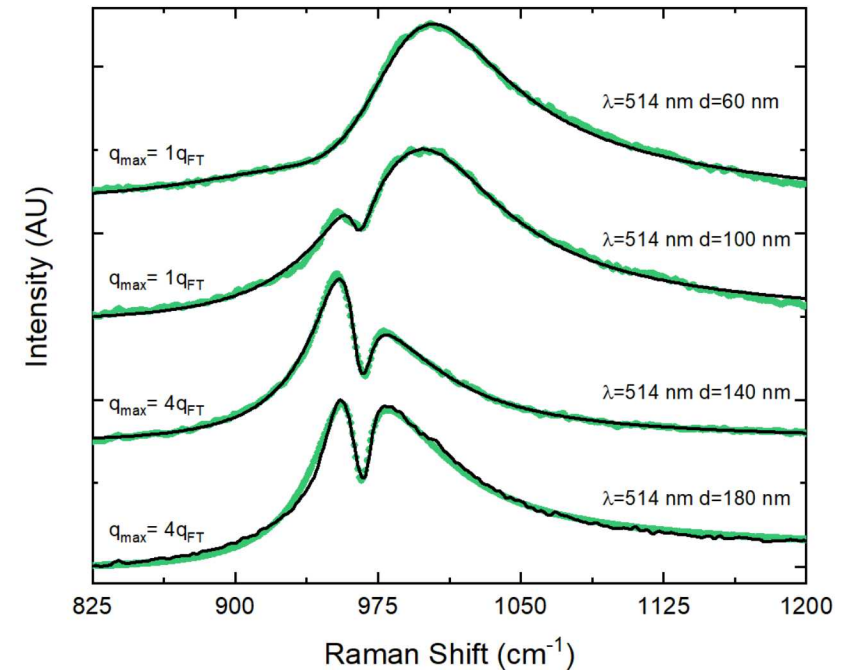
Game: Fit Raman Spectrum

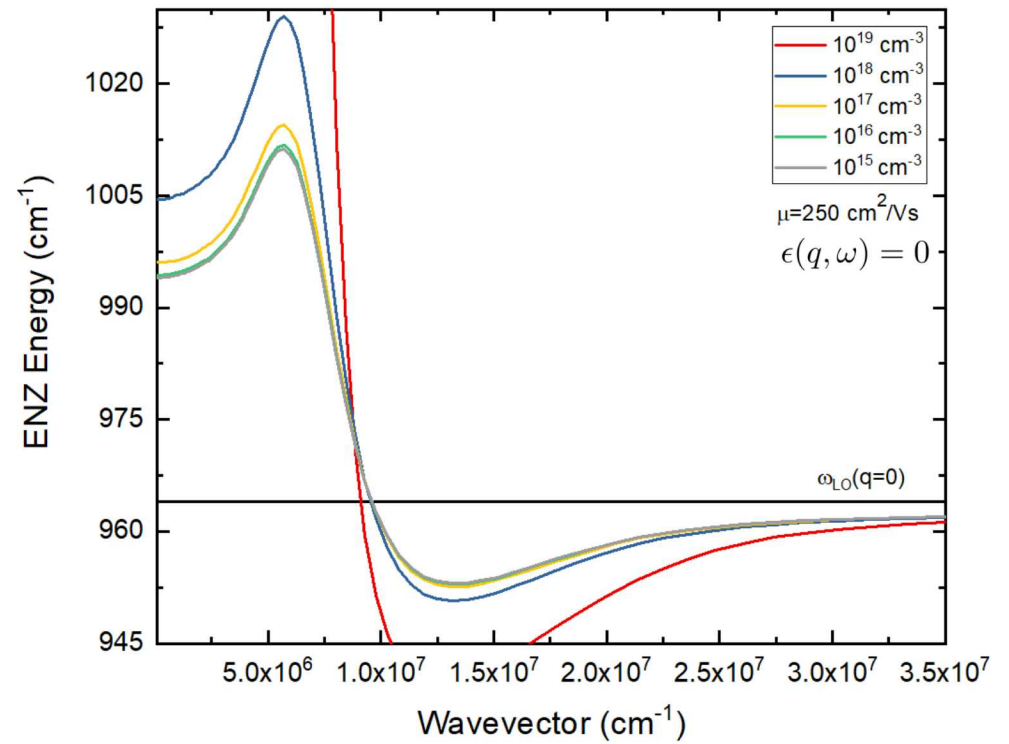
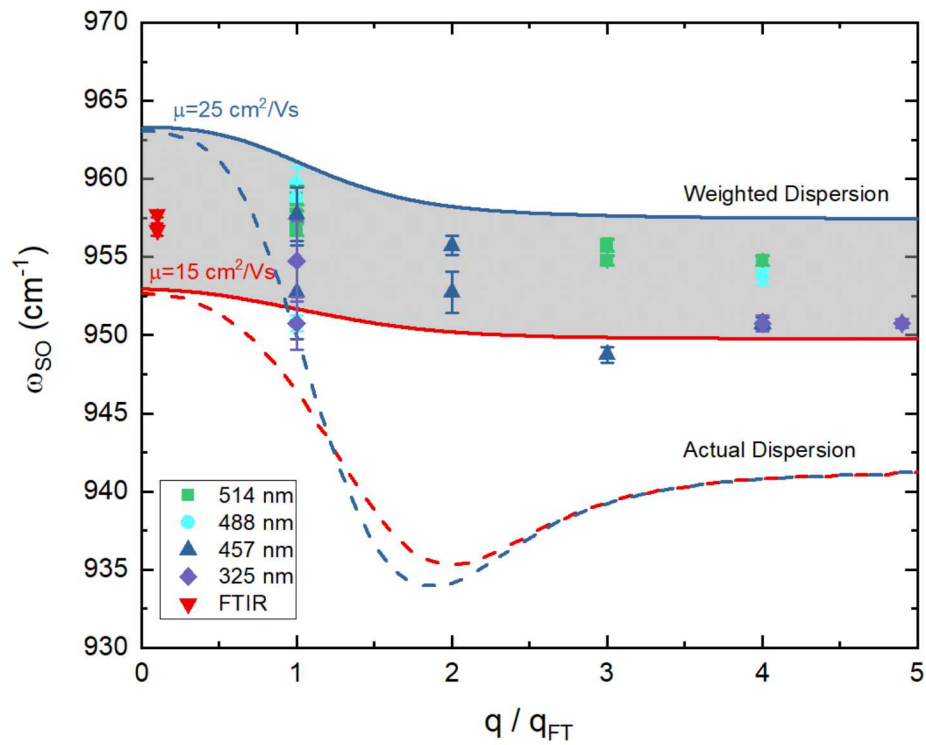
$$I_R \propto \sum_i \int_0^{q_{max}} F(q) S_i(q, \omega) \Im \left[-\frac{1}{\epsilon(q, \omega)} \right] dq + L_{SPhP}(\omega)$$

Lindhard-Mermin
Approximation

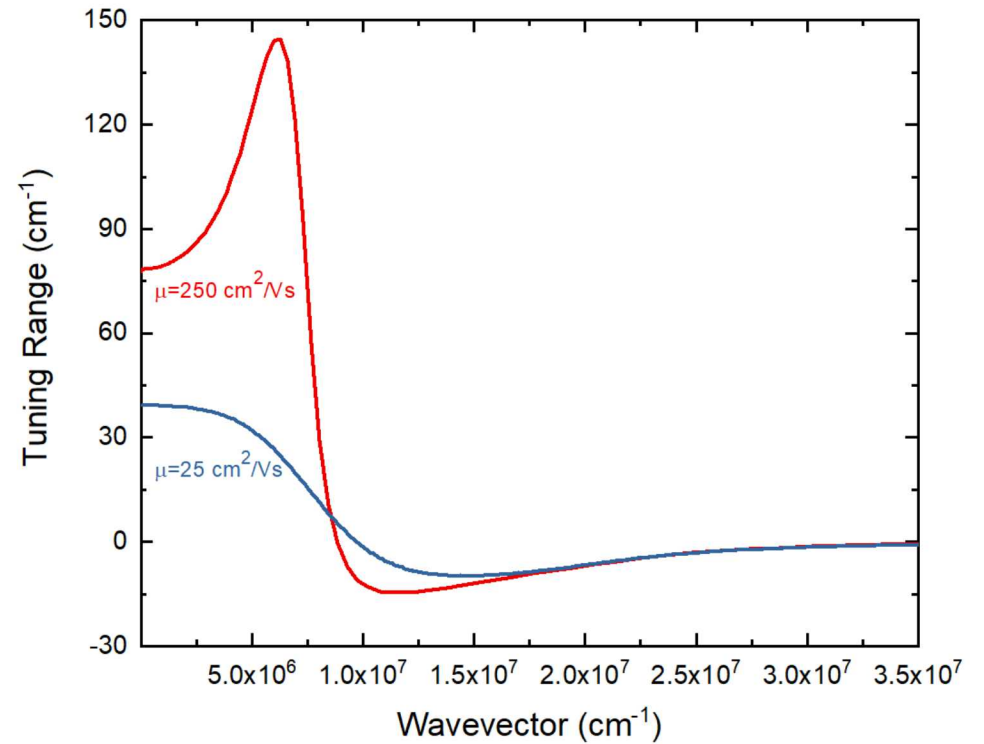
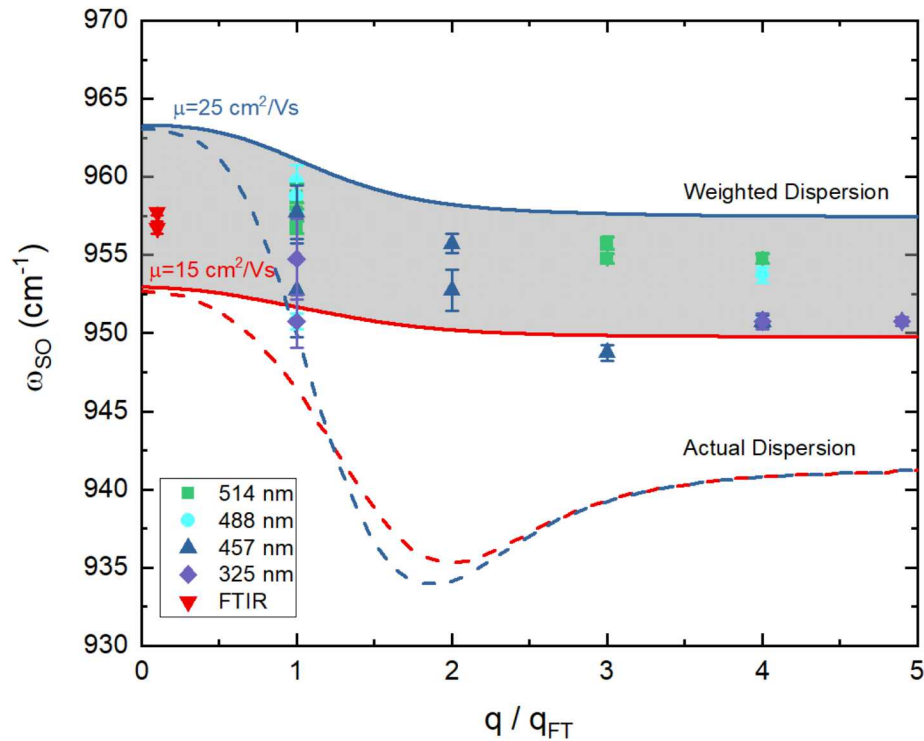
Surface-Phonon
Polariton (SPhP)

Momentum
Dependence of
Polariton?





An Observation & Gedanken



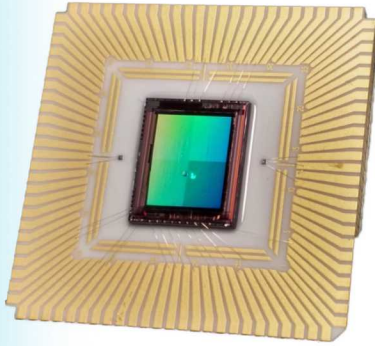
Takeaway: Some momenta provide greater tuning, q is a “knob”



Take Home Message

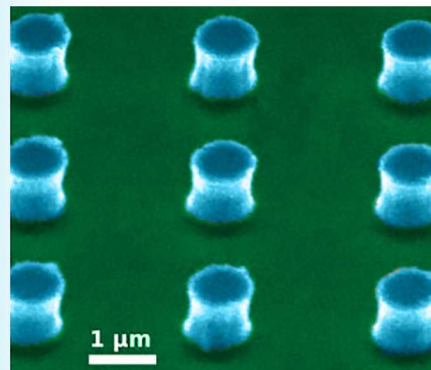


Vision



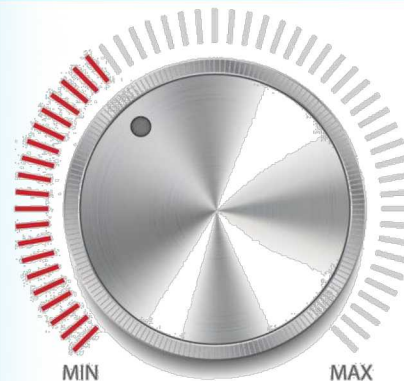
Dynamic, tunable, infrared sensing at pixel level

Path



Leveraging phonon polaritons for tuning

Outcome



Momentum is a "new" knob for tunable polaritonics