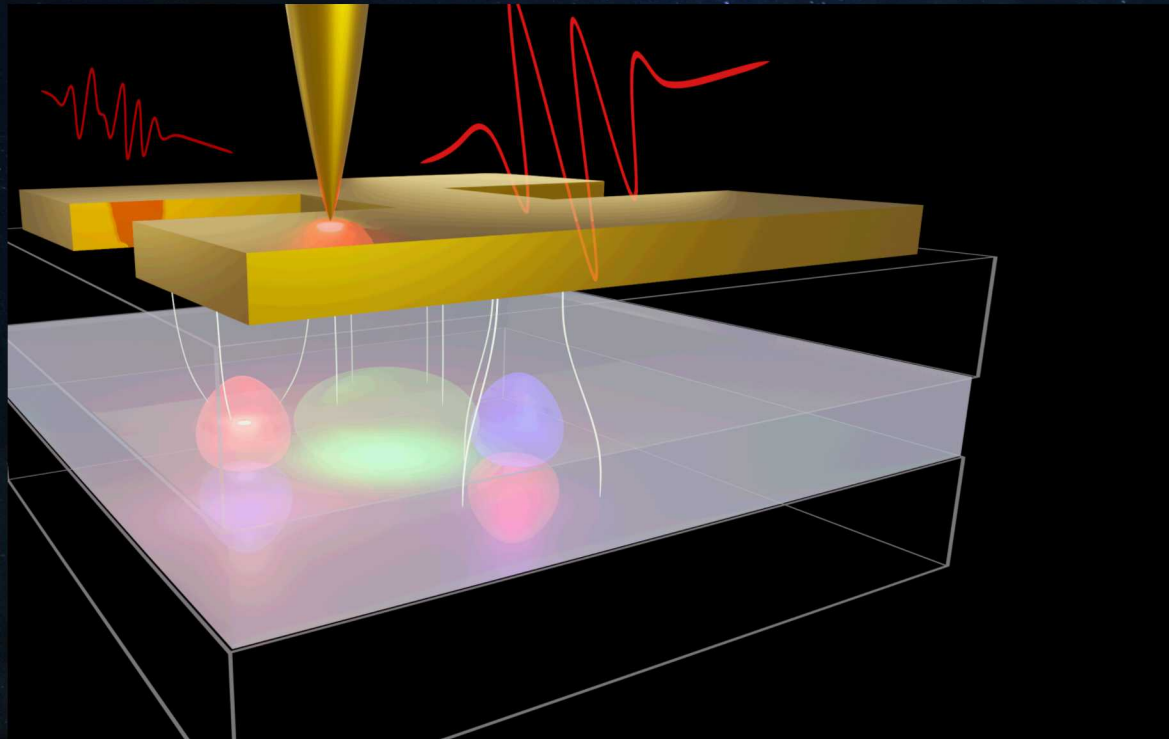


Near-field Spectroscopy of Inter-subband Polaritons in the Single Nanoantenna Regime

This paper describes objective technical results and analysis. Any subjective views or opinions that might be expressed in the paper do not necessarily represent the views of the U.S. Department of Energy or the United States Government.

SAND2019-11157C



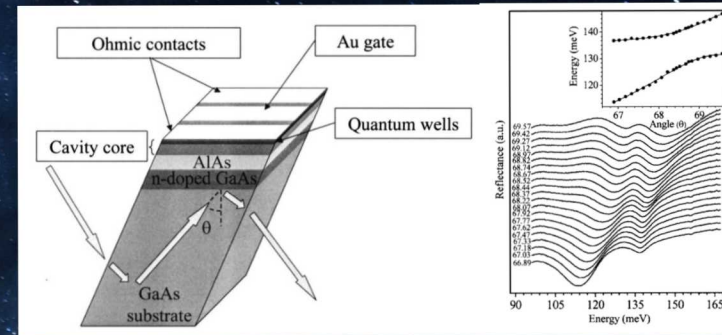
C.-F. Wang, T. G. Habteyes,
T. S. Luk, J. F. Klem,
Igal Brener, H.-T. Chen,
Oleg Mitrofanov

ITQW 2019, USA

CINT, Los Alamos Nat. Lab, USA
University of New Mexico, USA
CINT, Sandia Nat. Labs., USA
UCL, London, UK

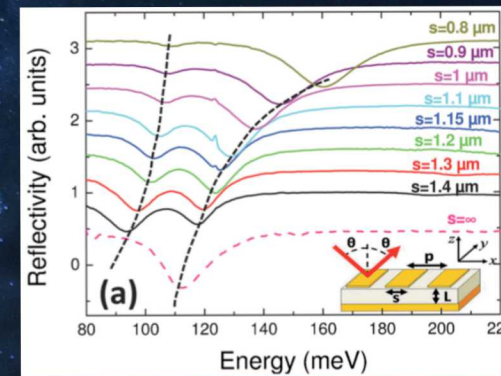


ISB Polaritons



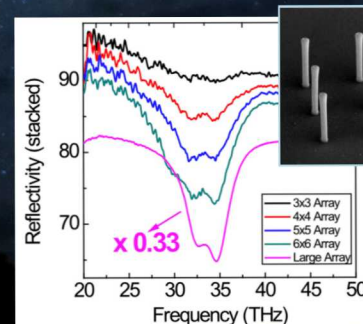
Anappara et al., APL 2005

ISB Polaritons in Resonator Arrays

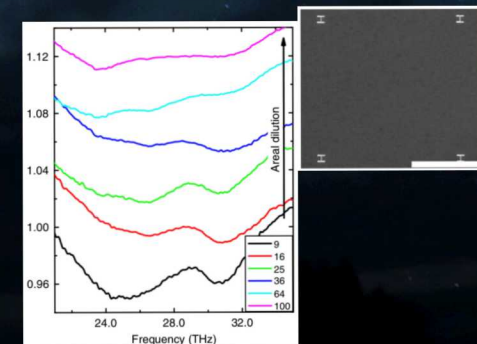


Jouy et al., APL 2011

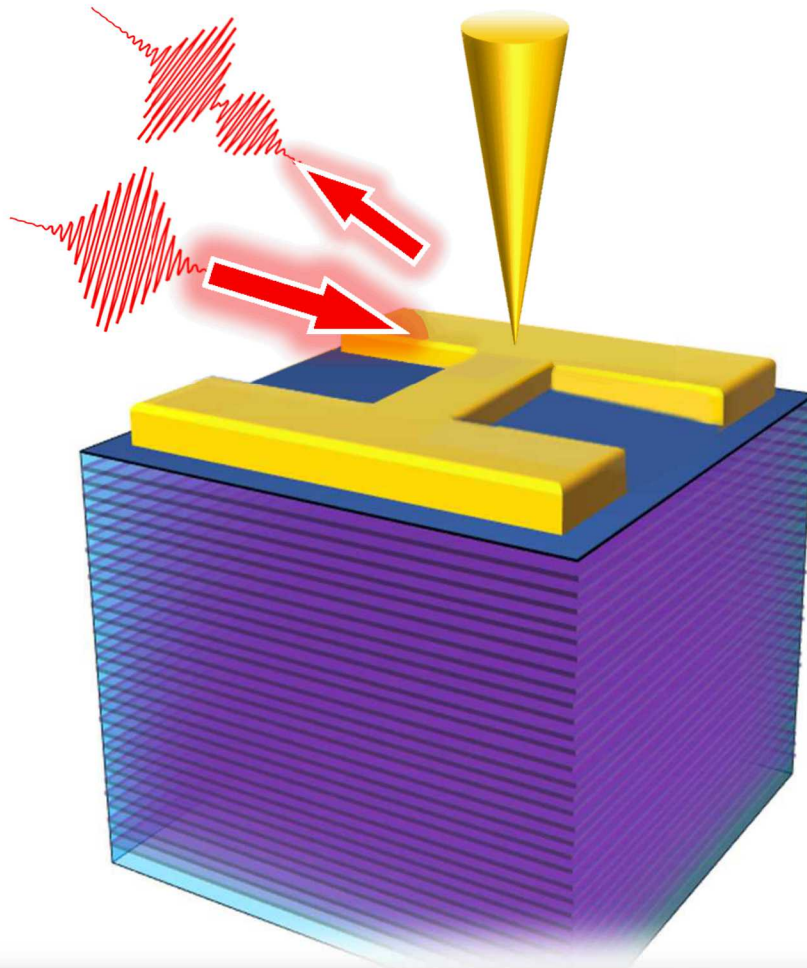
ISB Polaritons - towards Single resonator regime



Malerba et al., APL 2016



Benz et al., Nat C. 2013



QWs:

QW1 ISBT energy: 1150 cm^{-1}

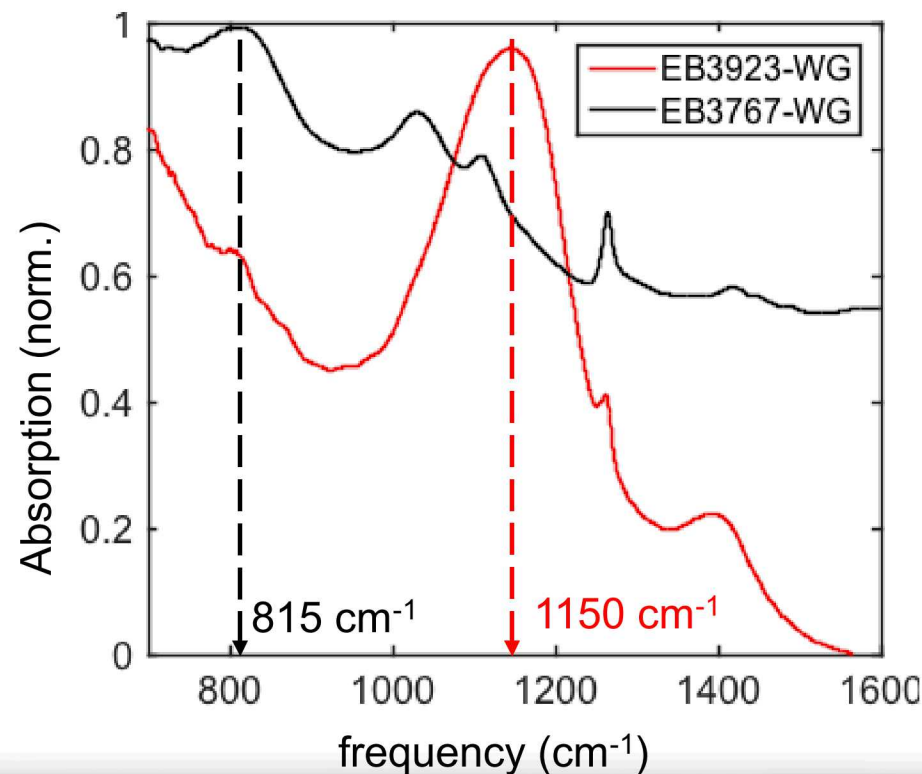
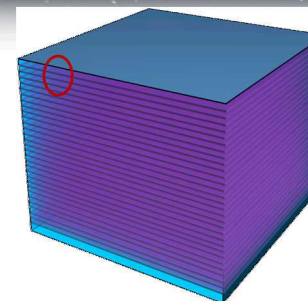
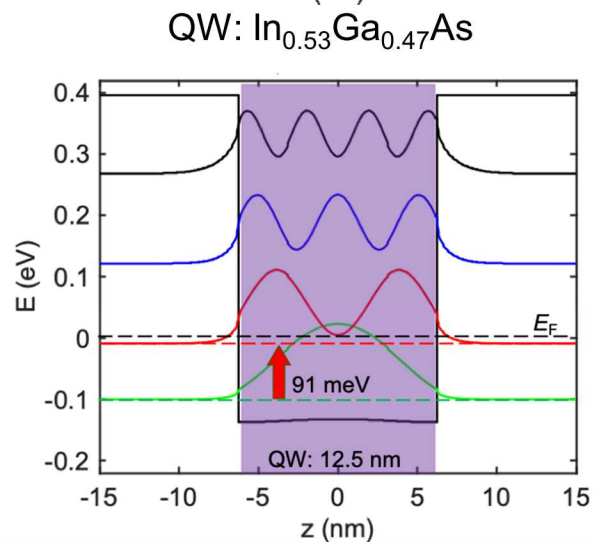
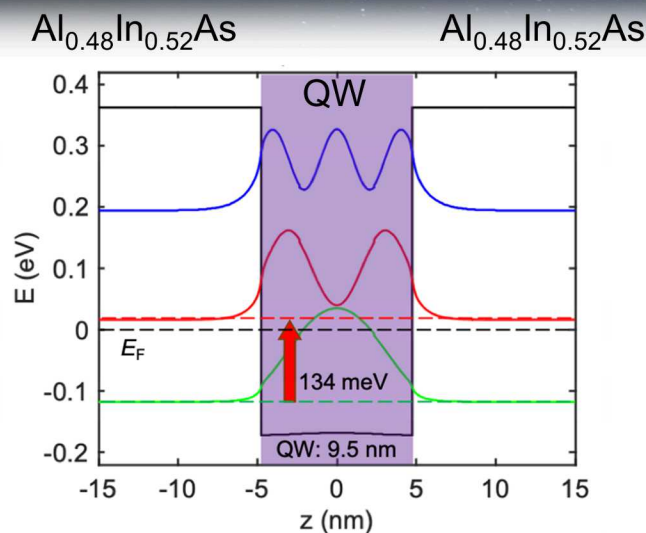
QW2 ISBT energy: 815 cm^{-1}

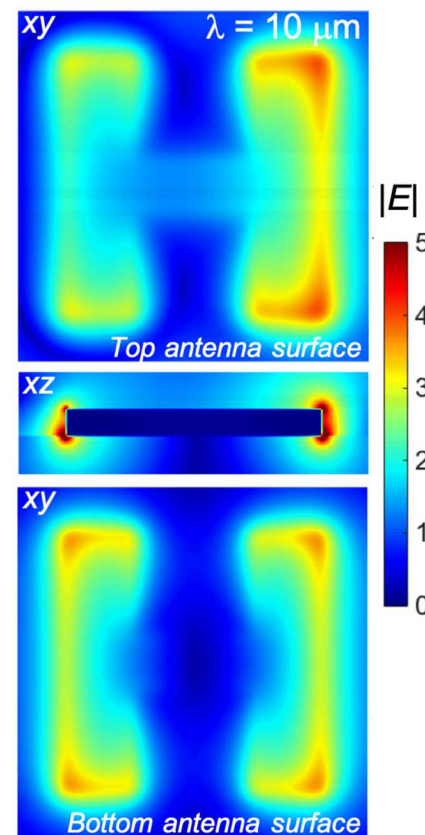
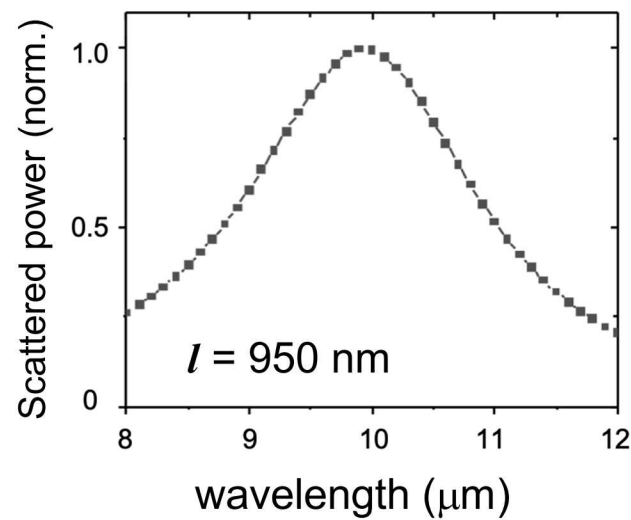
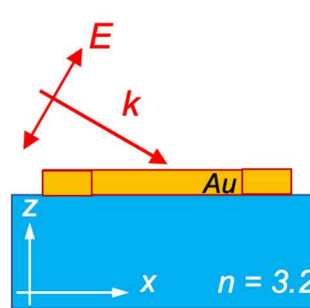
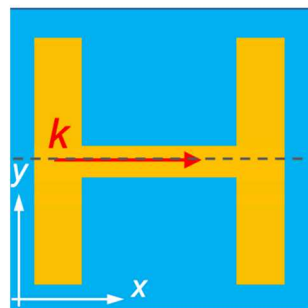
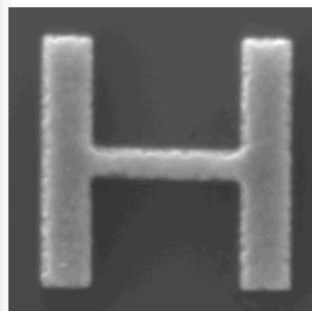
Dogbone antenna with
dipolar resonance near
the ISBT energy

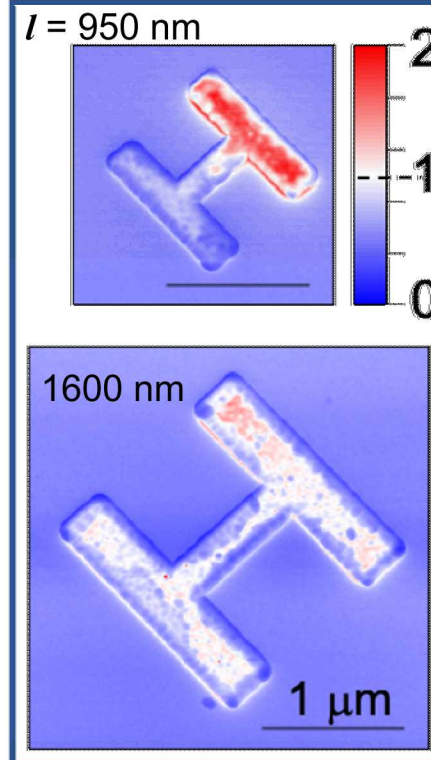
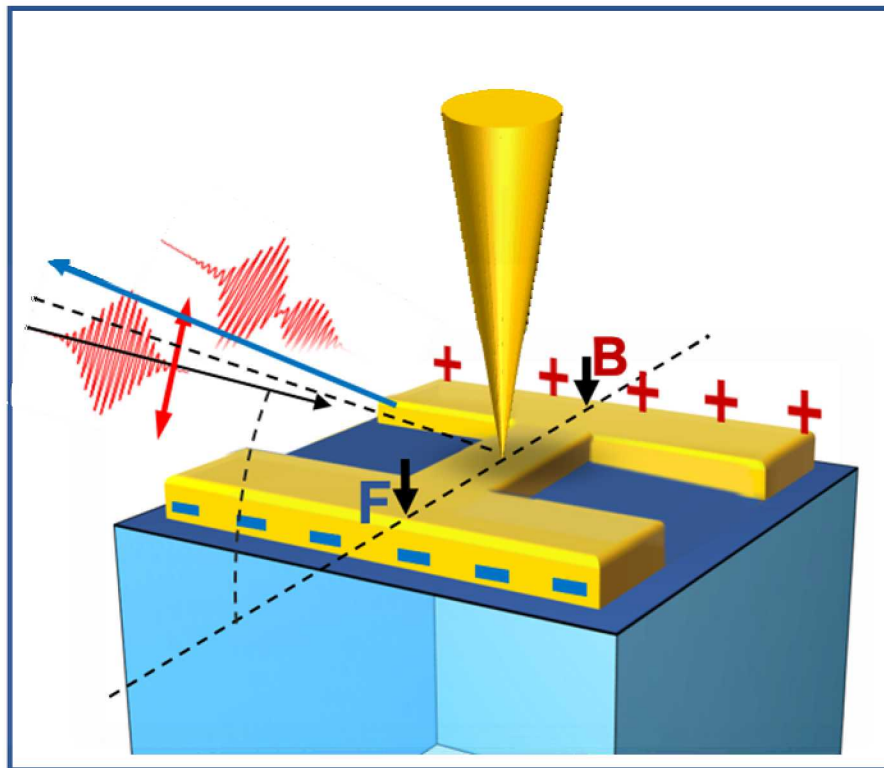
Scattering-type NSOM

CW: 1000 cm^{-1} QCL

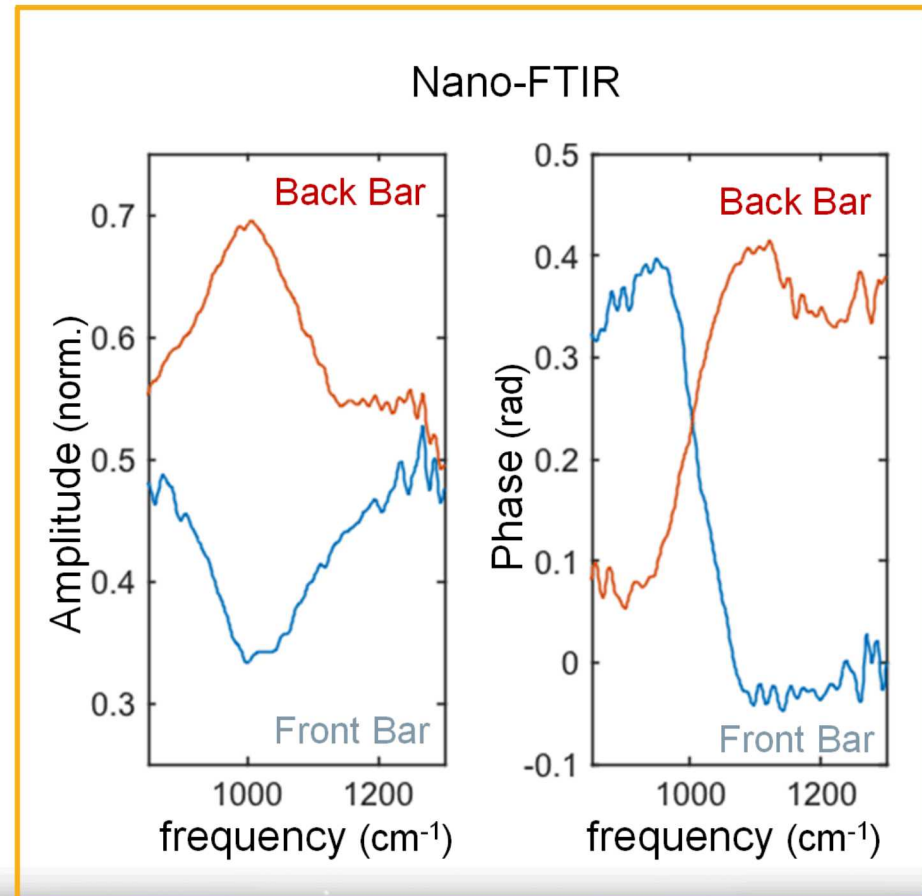
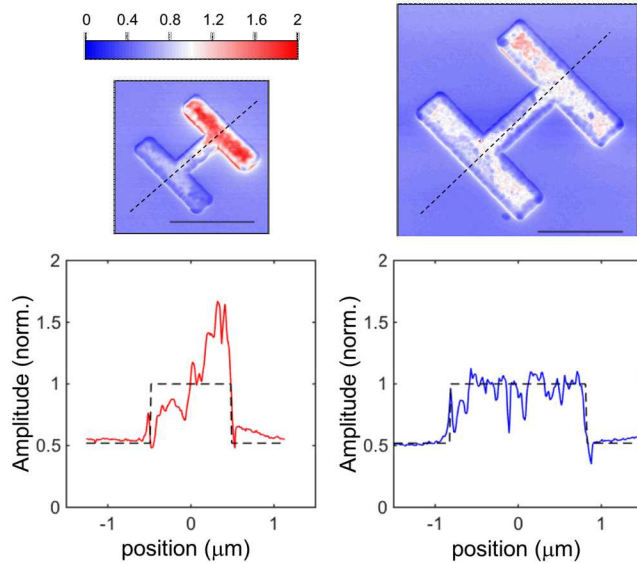
Nano-FTIR: DFG
($800\text{--}1400\text{ cm}^{-1}$)

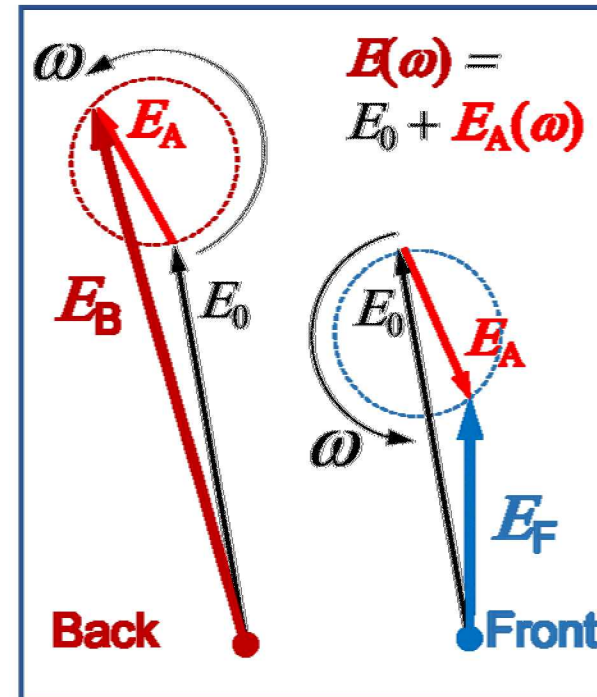
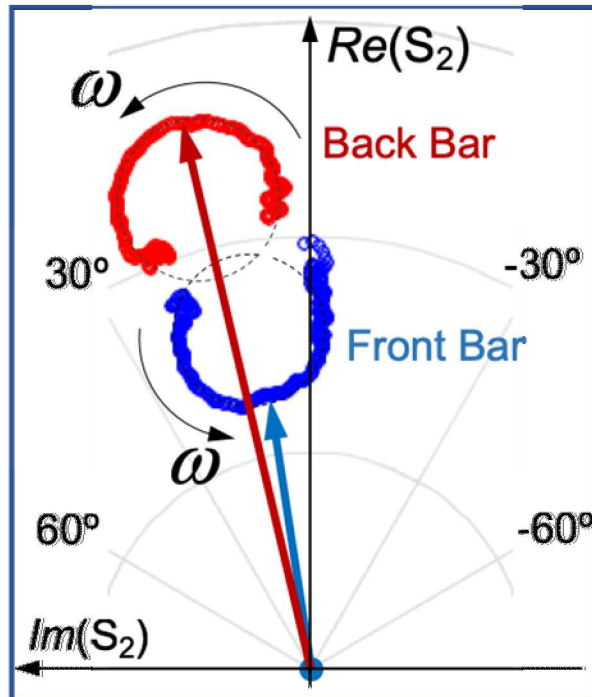


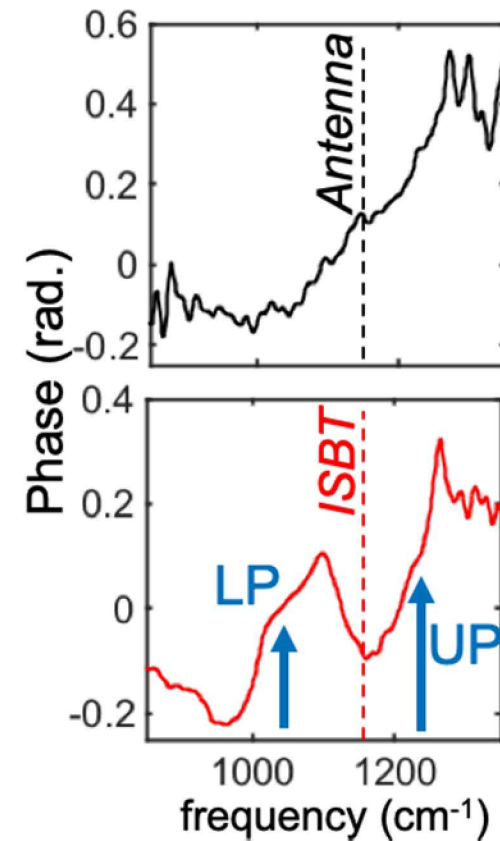
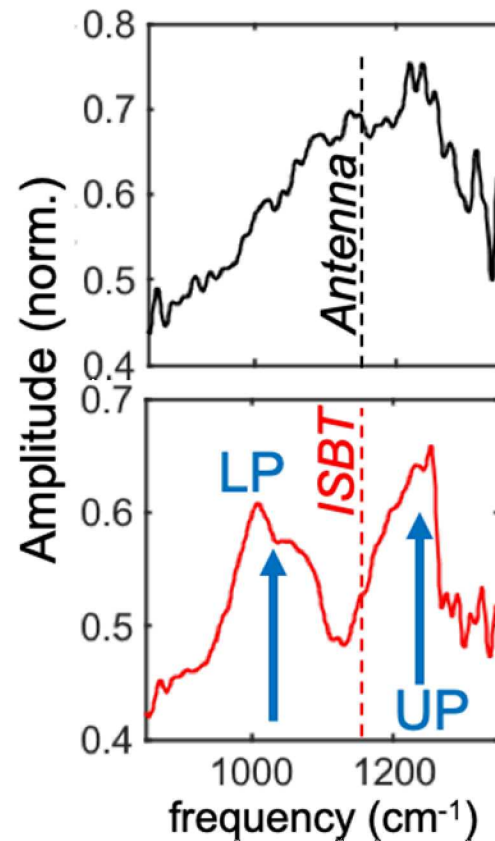
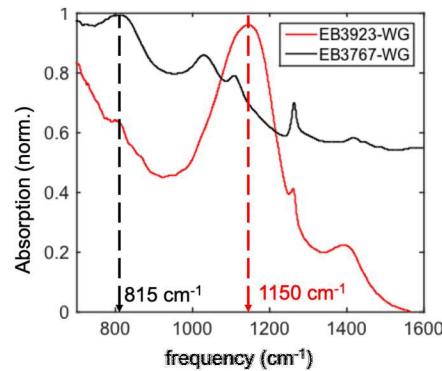


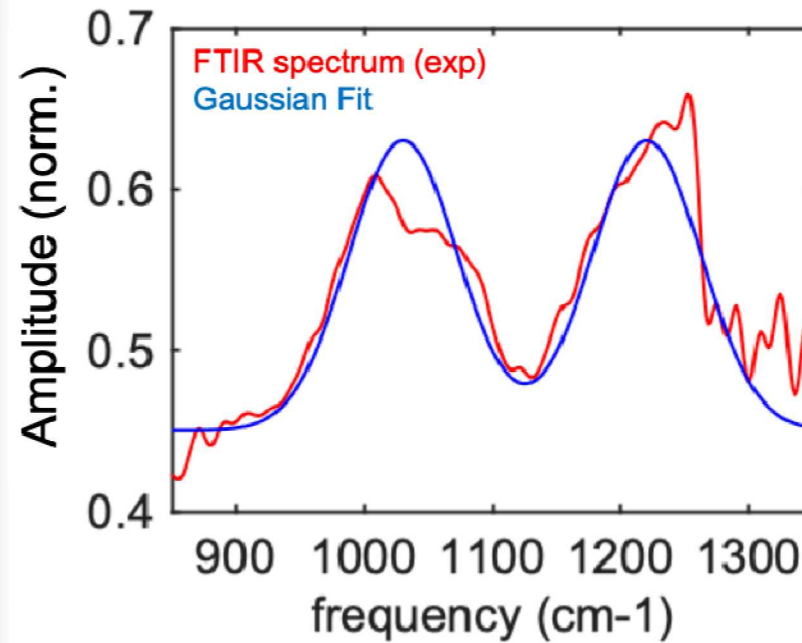


CW excitation (QCL)
 λ : $10 \mu\text{m}$ (1000 cm^{-1})

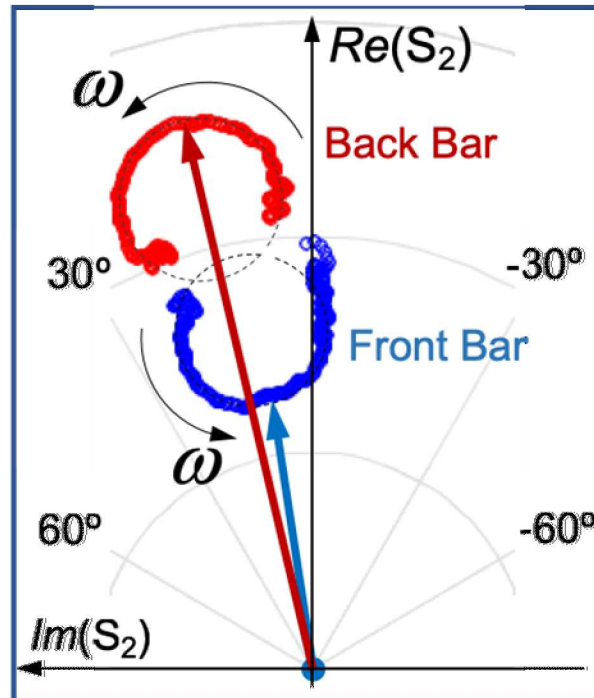




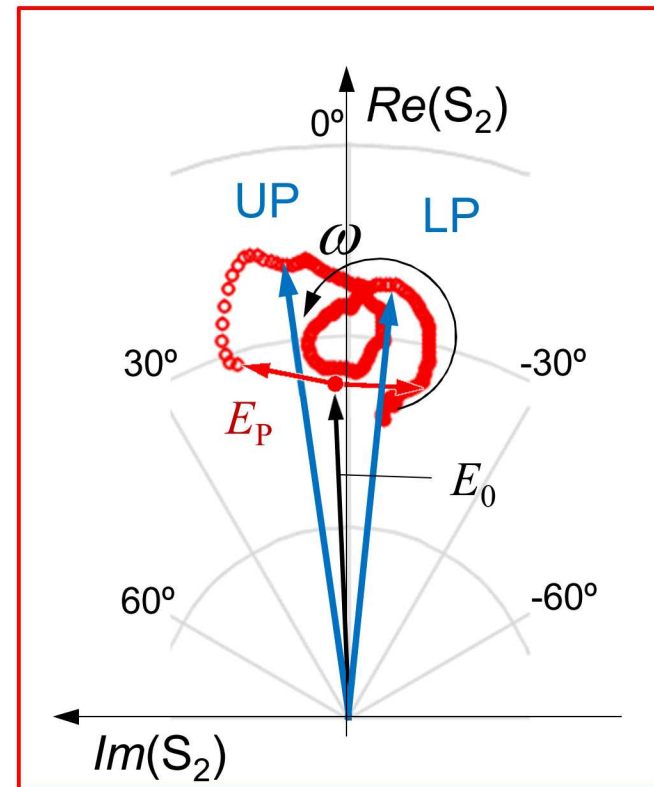


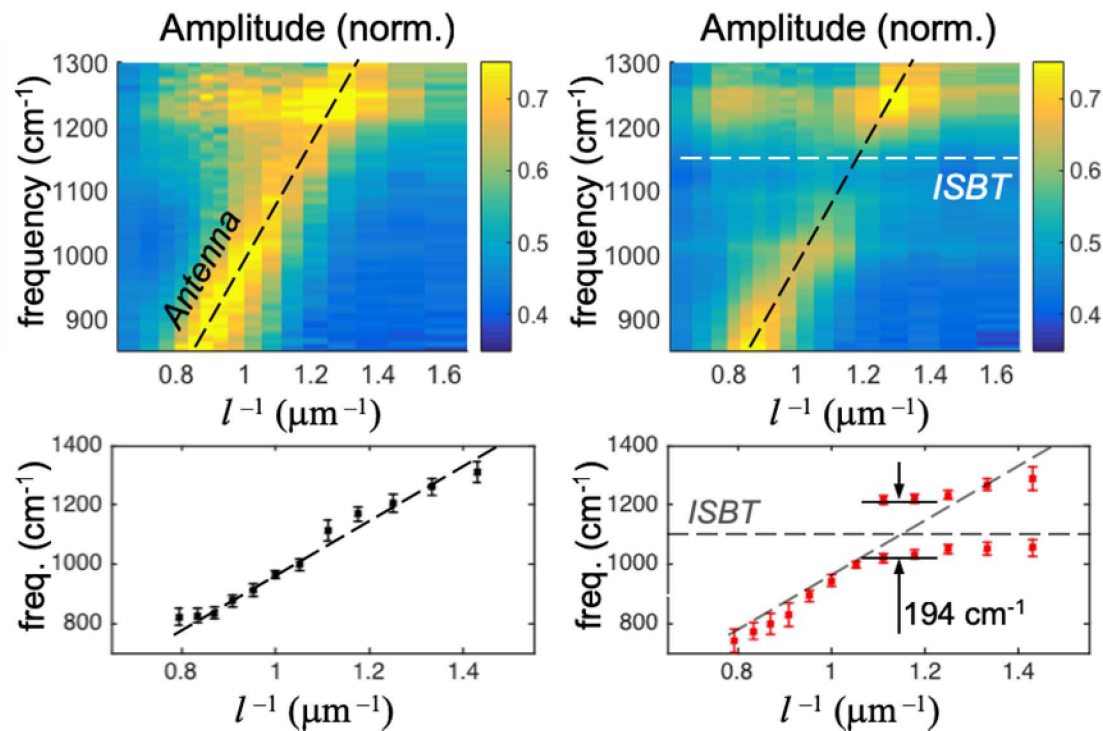
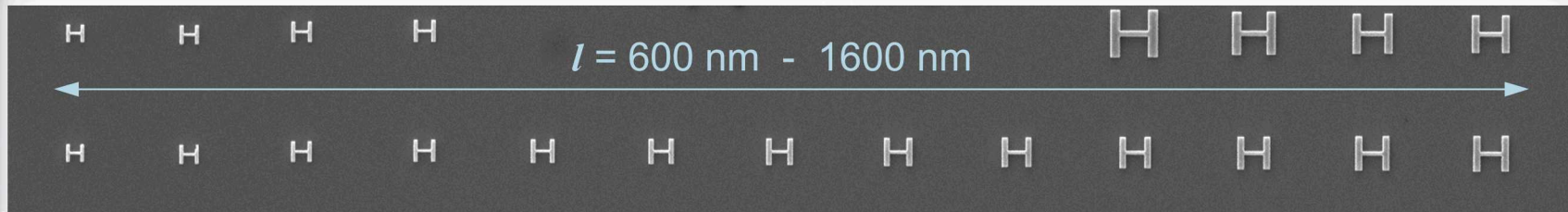


Single Antenna

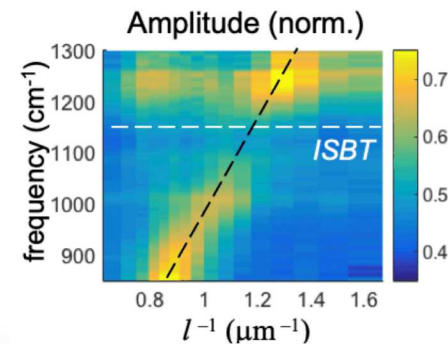
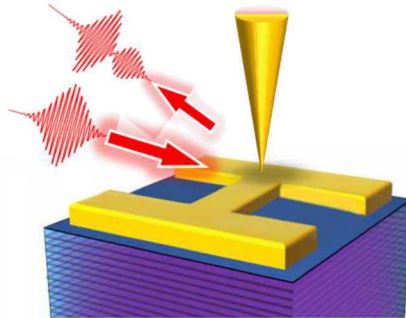


ISB Polaritons





ISB Polaritons are observed in single nano-antennae using s-SNOM

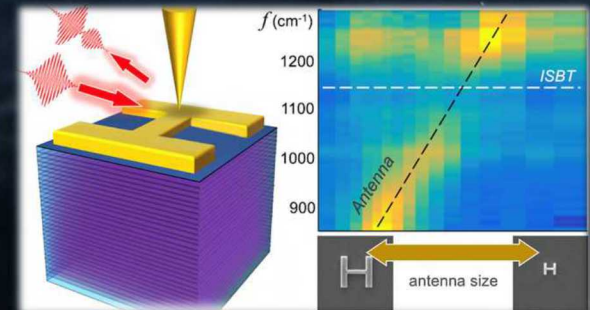


Evanescent fields on the nanoantenna surface contain information about polaritons

Nano-FTIR enables spectroscopic analysis (amplitude and phase) of polaritons in the single antenna regime

NF spectroscopy opens doors for studies of light-matter coupling using single nanoantennae

Thank You



Wang et al., *Nano Lett.* 2019, 19, 4620–4626