

Probing the Photonic Bandstructure by Responsivity Enhancement in OWIPs

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Overview



Detecting Region = PhC Slab





Excitation via Surface



Enhancement of Photocurrent



Other Principles



Characterizing in Reflection

- illuminate PhC-slab surface with broadband source

- features in reflected signal



Motivation



2D Photonic Crystals enable...





Science 302, 1374 *(2003)* Colombelli *et al.*

Quantum Cascade Surface-Emitting Photonic Crystal Laser







Quantum Well Infrared Photodetector



Photonic Crystal

ITQW 2007, Ambleside, UK, Sept 11th 2007

Surface Plasmon Waveguide





OWIP



Feature of QWIP:

- only TM sensitive (electric field component normal to layers)
- no response for surface incident light



Solutions:

- facets
- grating couplers
- photonic crystals
- QDIPs

OWIP – Reference Sample





2D Optical Bandstructure



Plane Wave Expansion Method (PWEM) n_{eff} =3.1984 a=3µm r/a=0.241 TM





ITQW 2007, Ambleside, UK, Sept 11th 2007

Fabricated Devices













Shallow "PhC" at Normal Incidence





Shallow "PhC" at Normal Incidence





Shallow "PhC" – Angle resolved









deep





Deep Etched PhC at Normal Incidence





Angular Dependence





Angular Dependence





Bandstructure Mapping





Schartner et al., Appl. Phys. Lett., 89, 151107 (2006)

Polarization Resolved





Polarization Resolved





Polarization Resolved





Symmetry



E_z-Field of 2nd Band at Γ-Point



Symmetry





Propagation along TM



Symmetry





Propagation along *FK*









Parity - Polarization





- Plane Wave is always even





TM - TE mixing

Normalized E-Field Strength / (a.u.)



In Plane Mode Profiles

Precondition

- grating/PhC

- overlap of in plane components of both modes



Summary



- PhC QWIPs are sensitive to surface incident light
- Polarization behavior and band structure mapping in surface plasmon PhCs
- Defect modes



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GMe