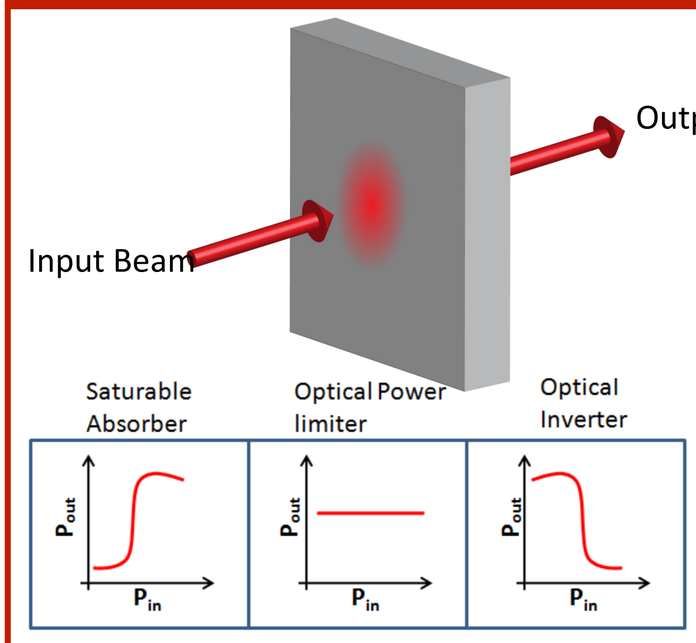
Ming Hsieh Department of Electrical Engineering

USC Viterbi School of Engineering

Non-linear power shaping meta-surfaces

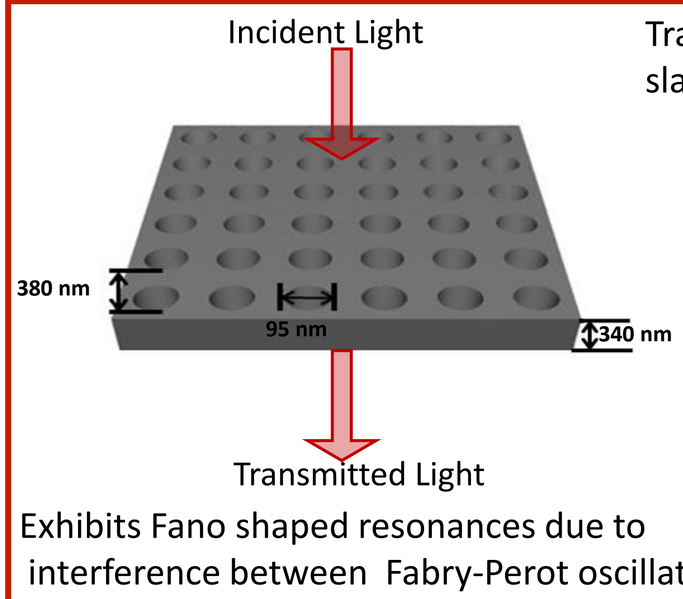
Roshni Biswas, Chenxi Lin, Michelle L. Povinelli
Povinelli Nanophotonics Laboratory

Motivation



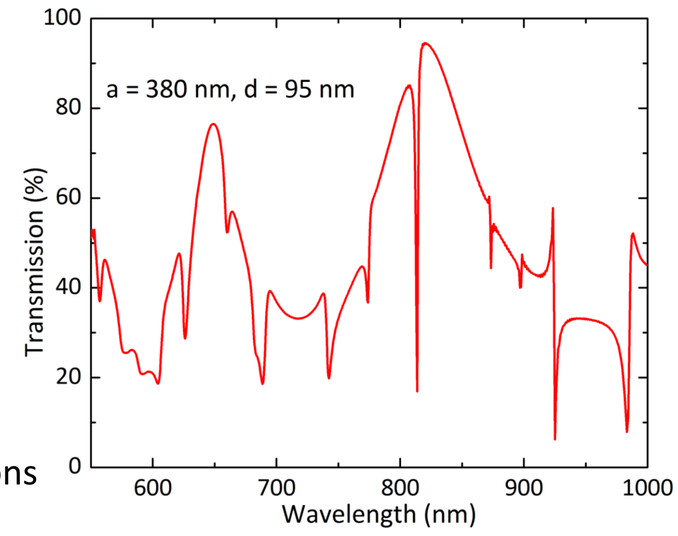
Arbitrary power shaping meta-surface through passive control of light

Background



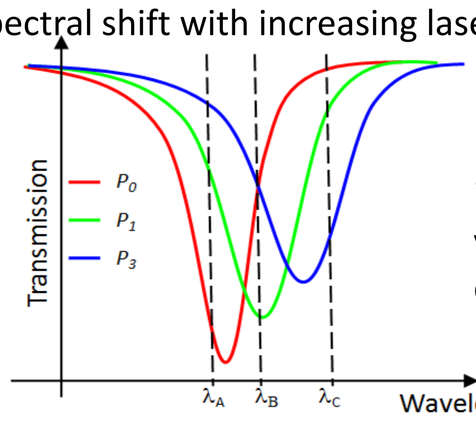
Exhibits Fano shaped resonances due to interference between Fabry-Perot oscillations and guided resonance modes [1]

Transmission spectrum of silicon photonic crystal slab

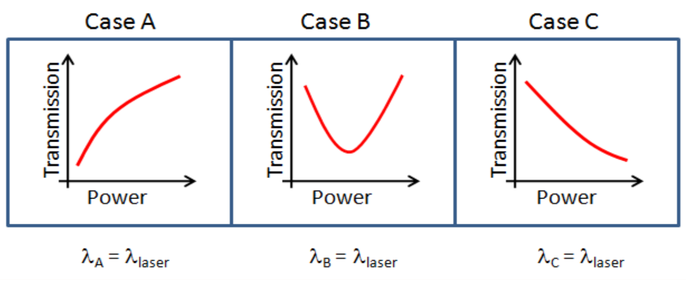


Non-linear power transmission utilizing Fano shaped modes

Spectral shift with increasing laser power ($P_0 < P_1 < P_2$)

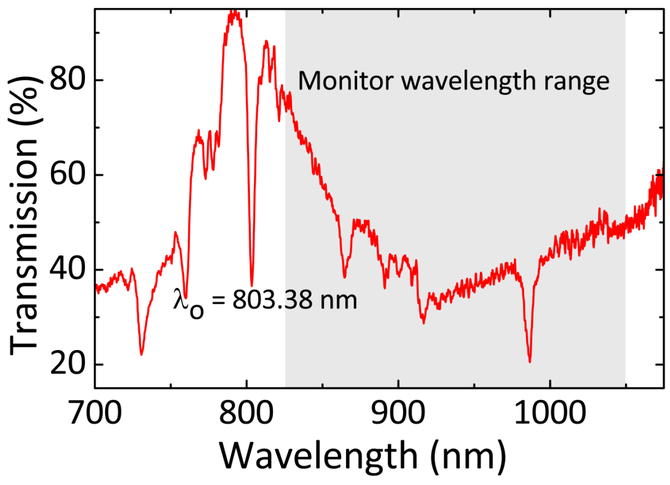


Induced by refractive index variation due to optical absorption

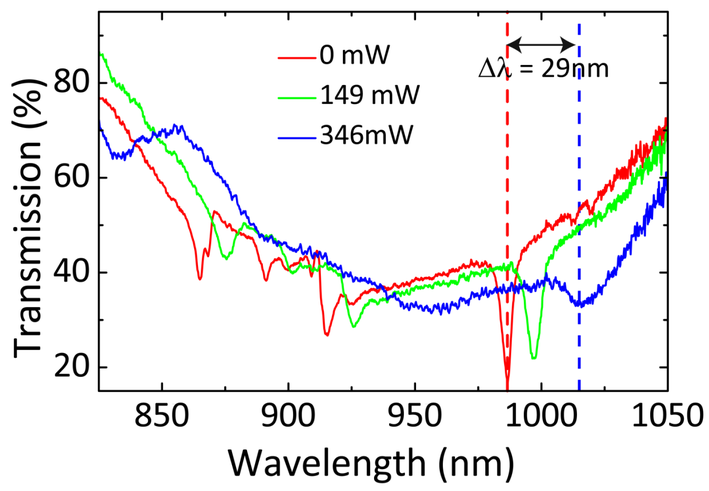


Fixing laser at different points on the spectrum yields different trends

Evidence of spectral shift at monitor wavelength



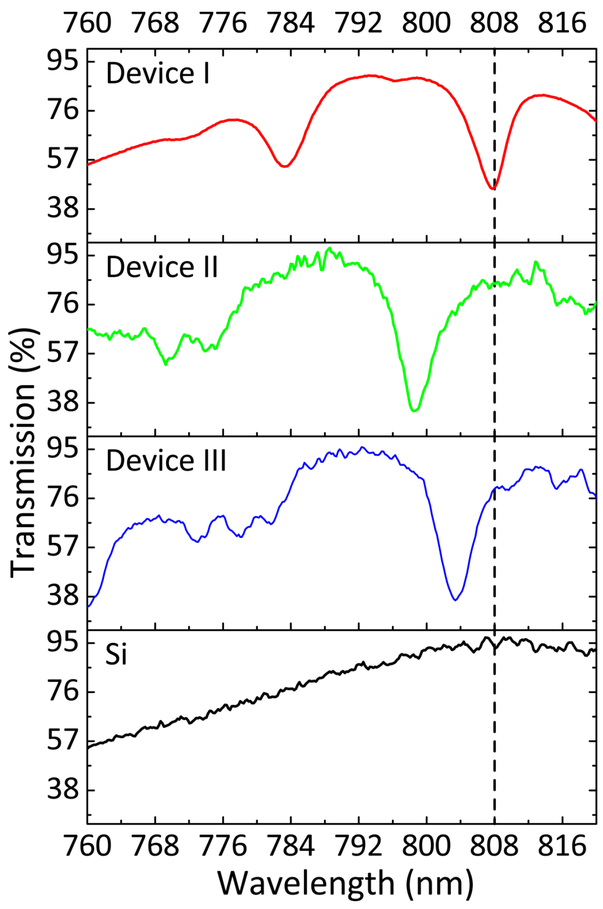
Spectrum with laser off
Laser, operating at 808nm, red detuned representing Case B



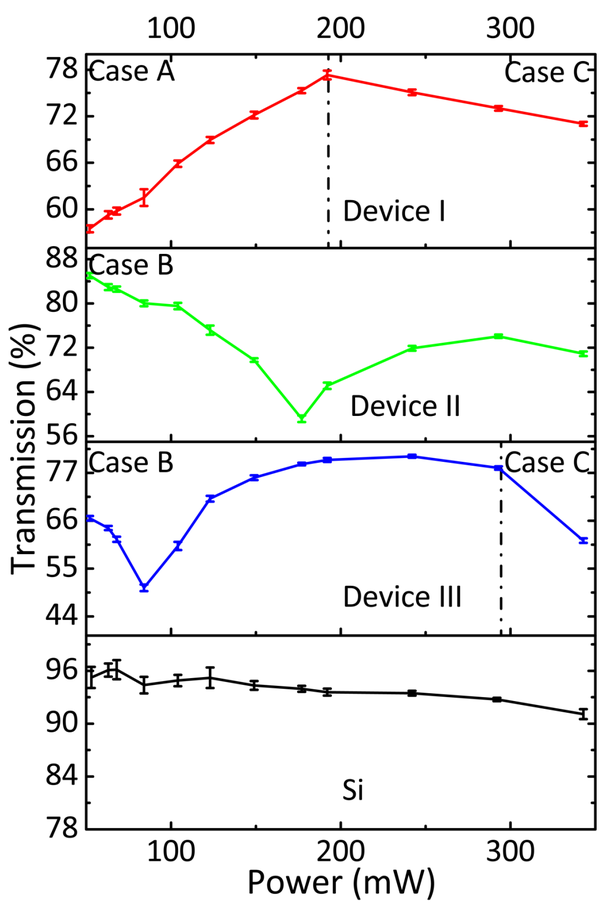
Red spectral shift suggests dominant thermo-optic effect

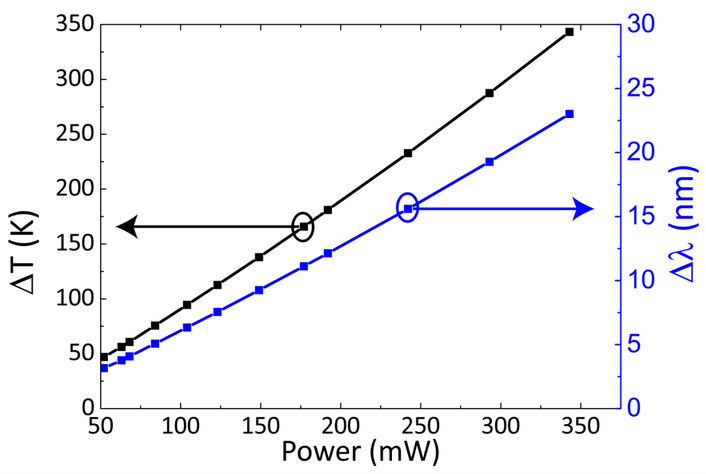
Experimental results

Spectrum of different devices and un-patterned silicon membrane with laser turned off



Non-linear transmission with increasing laser power





Free carriers generated by optical absorption thermalize with the lattice increasing temperature

Calculated spectral shift induced by thermo-optic effect

Conclusions

- Large spectral shift (~23 nm) induced by increasing laser power causes non-linear power transmission
- Red spectral shift suggests dominant thermo-optic effect attributed to linear absorption of silicon
- Nano-patterning of silicon membrane reduces thermal conductivity leading to enhanced temperature rise [2].

References

1. S.Fan, J.Joannopoulos, *Analysis of guided resonances in photonic crystal slabs.* Physical Review B, 2002. **65**(235112): p. 1-8.

2.J.Tang, H.Wang, D.H.Lee,M.Fardy, Z.Huo, T.P.Russell, P.Yang, *Holey Silicon as an Efficient Thermoelectric Material.* Nano Letters, 2010. **10**: p. 4279-4283.

This work is funded by a National Science Foundation CAREER award under Grant No. 0846143.

Ming Hsieh Institute
Ming Hsieh Department of Electrical Engineering