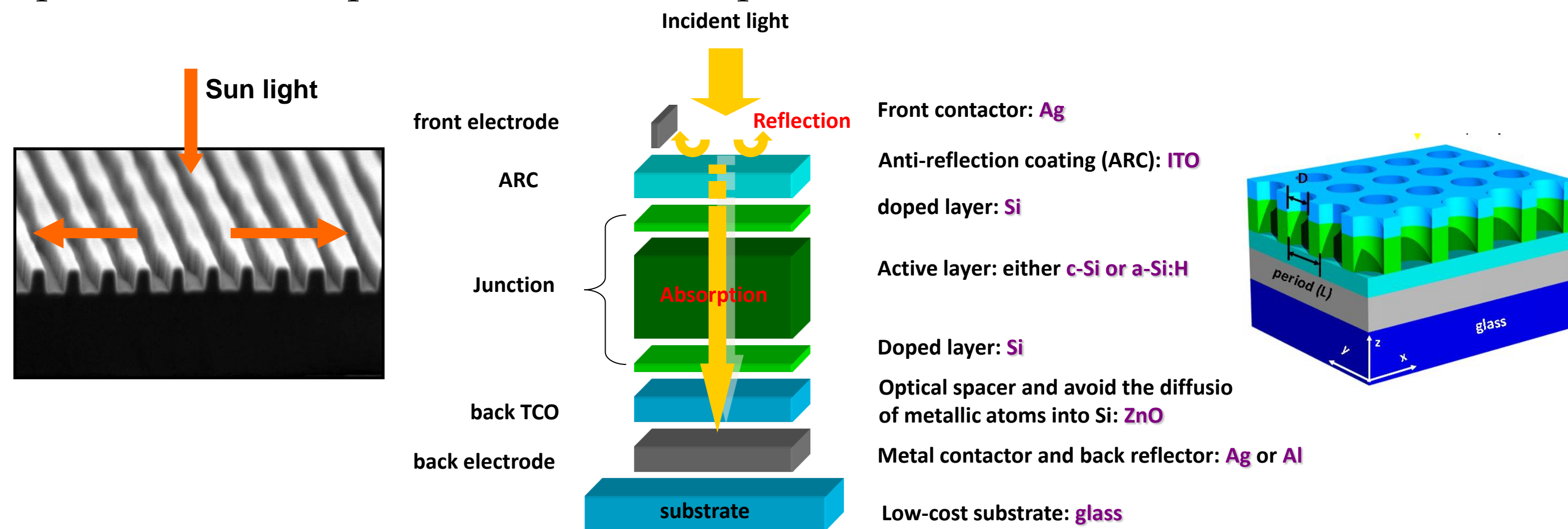


## Context

### • Photonics for ultrathin film photovoltaic cells:

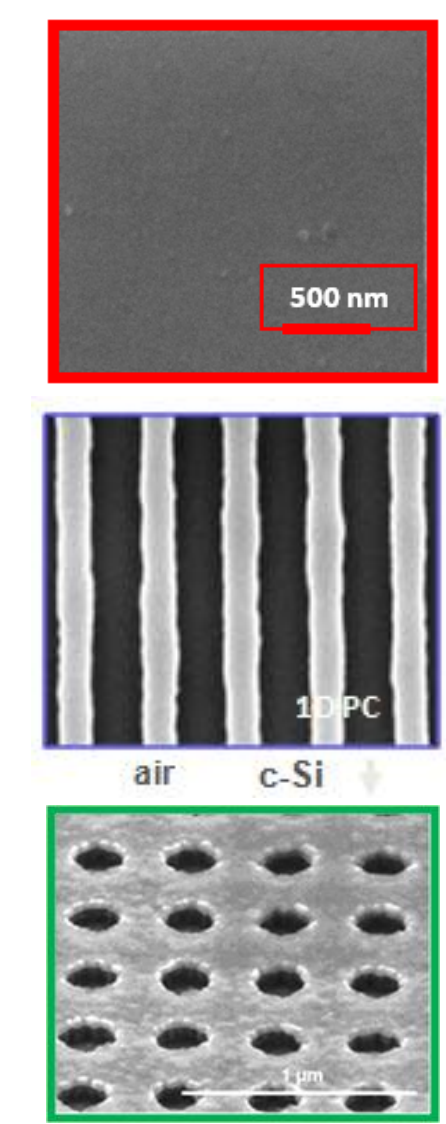
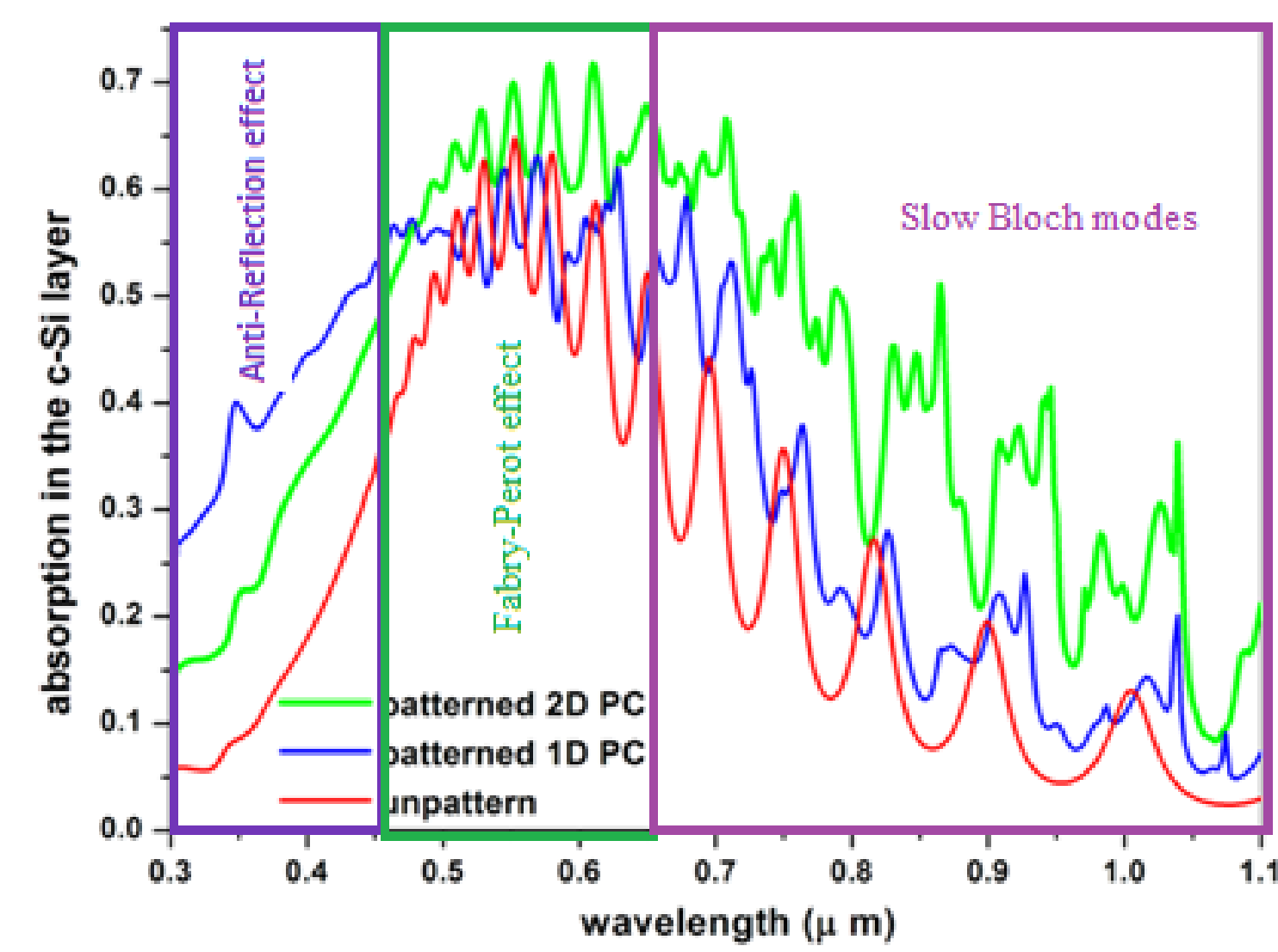
- Maximise the collection of the incident sunlight
- Optimise the absorption of the collected photons



Among various solutions, Photonic Crystal structures are a promising way to enhance light trapping in thin film solar cells

## Ph. crystal thin film SC absorption

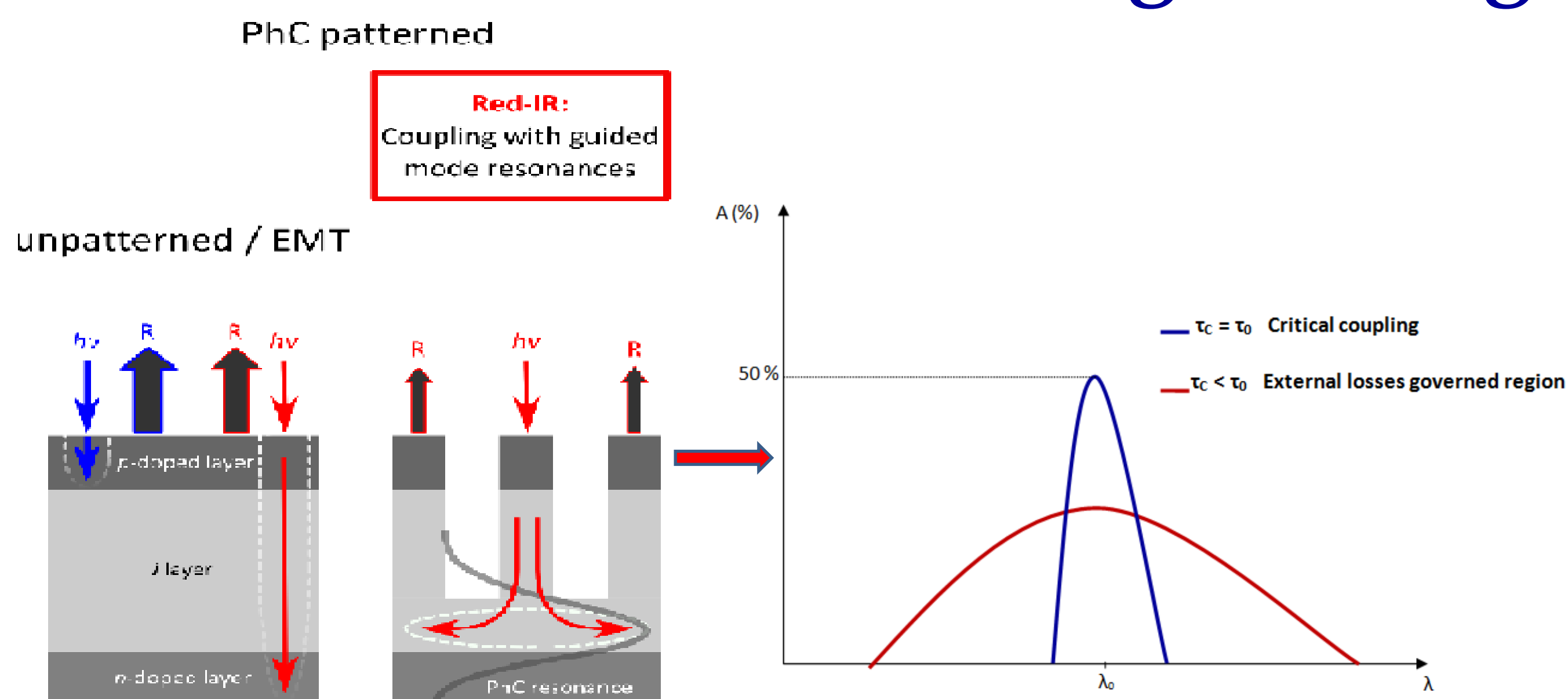
First optimization results:



Possible further improvements ?

:X.Meng *et al.*, "Design fabrication and optical characterization of photonic crystal assisted thin film monocrystalline-silicon solar cells". *Optics Express* 20, A465

## Modal Engineering at large Wavelengths (red)



Incident light coupling into Slow Bloch Modes (SBM):

Condition for critical coupling between the incident light and a SBM:

→  $\tau_0 = \tau_c$  (absorption losses = coupling losses)

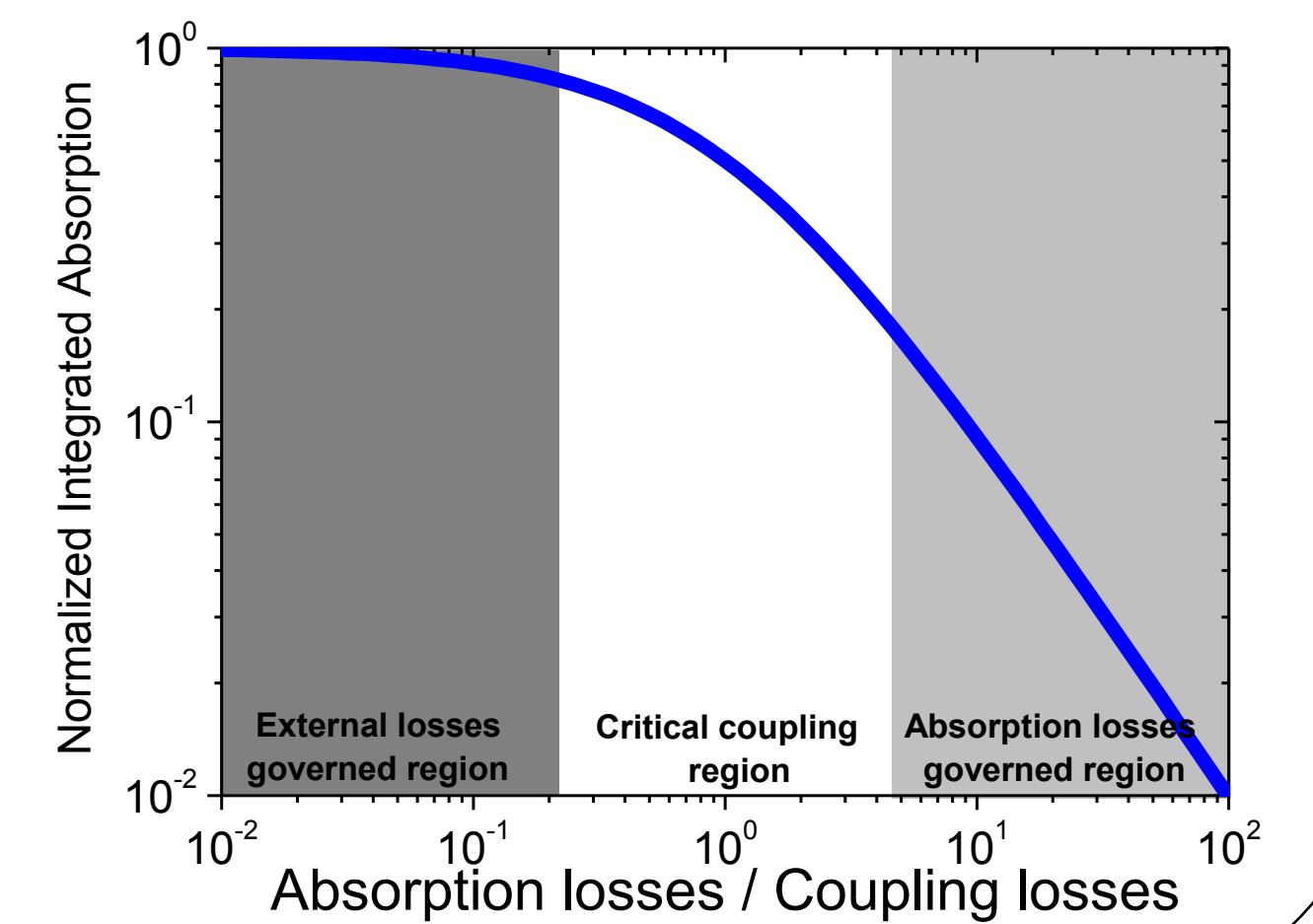
Max peak absorption of 50% at the resonant wavelength of the SBM

Condition for stronger coupling between the incident light and a SBM :

→  $\tau_0 < \tau_c$  (external losses governed region of the spectrum)

Lower absorption peak value, but larger width

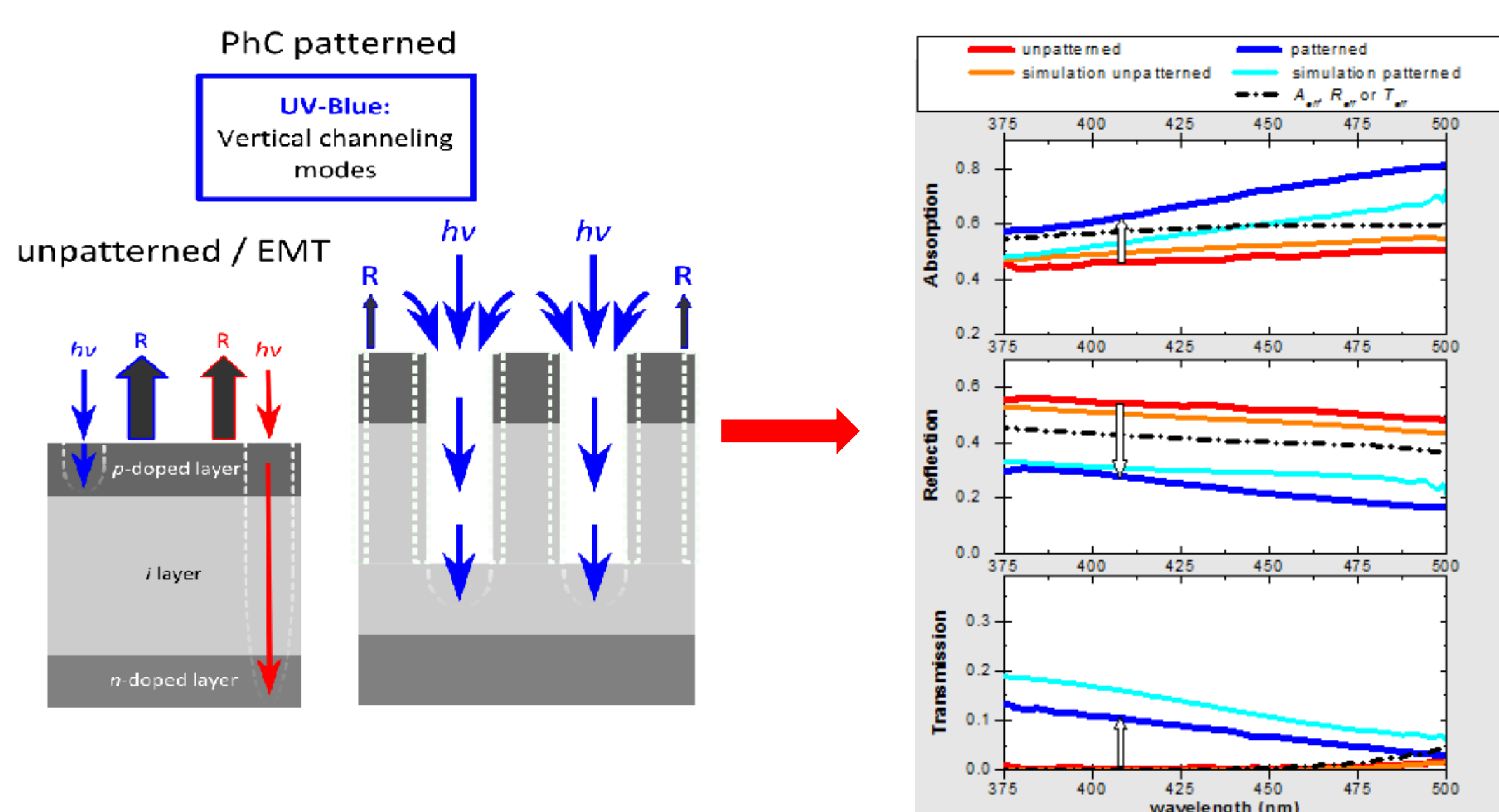
➔ Larger integrated absorption:



Gomard *et al.*, *Optics Express*, Vol. 21, Issue S3, pp. A515-A527 (2013)

## Enhanced absorption by channeling at low wavelengths (blue)

### Optical properties



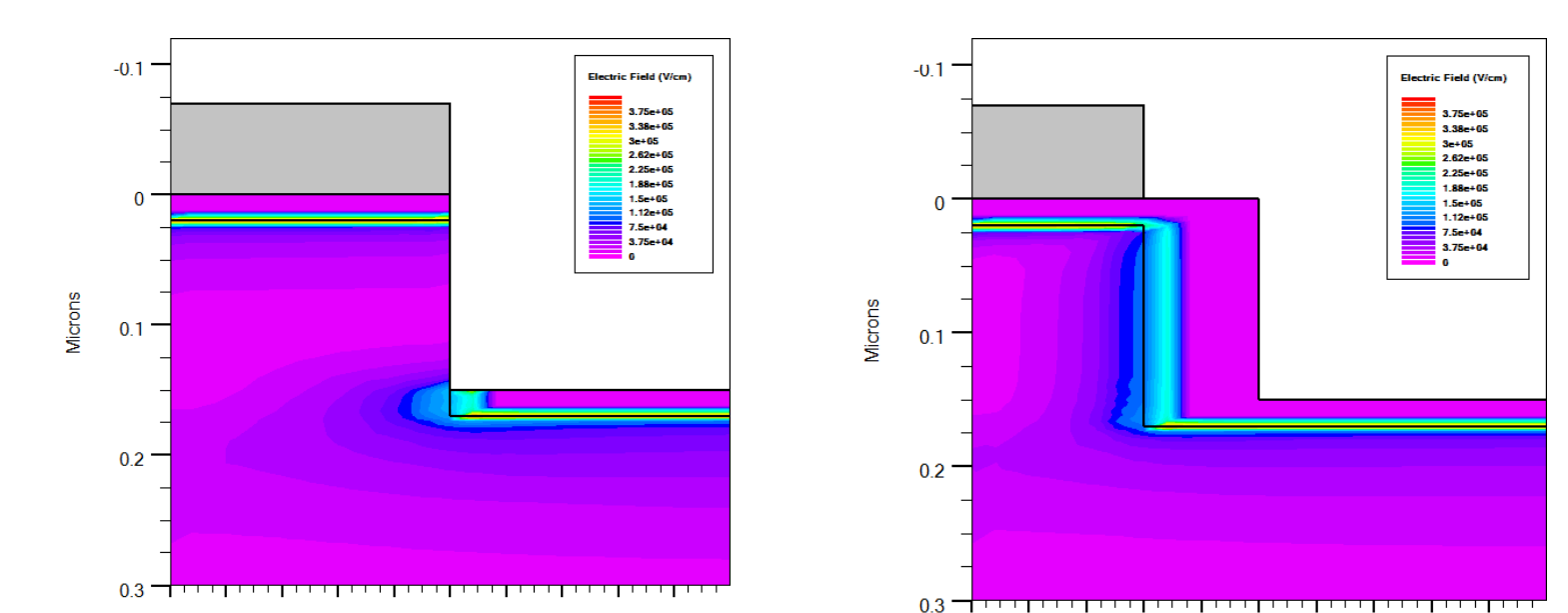
• Effective index medium theories not suitable for R, T and A description

• Channeling in nanoholes:

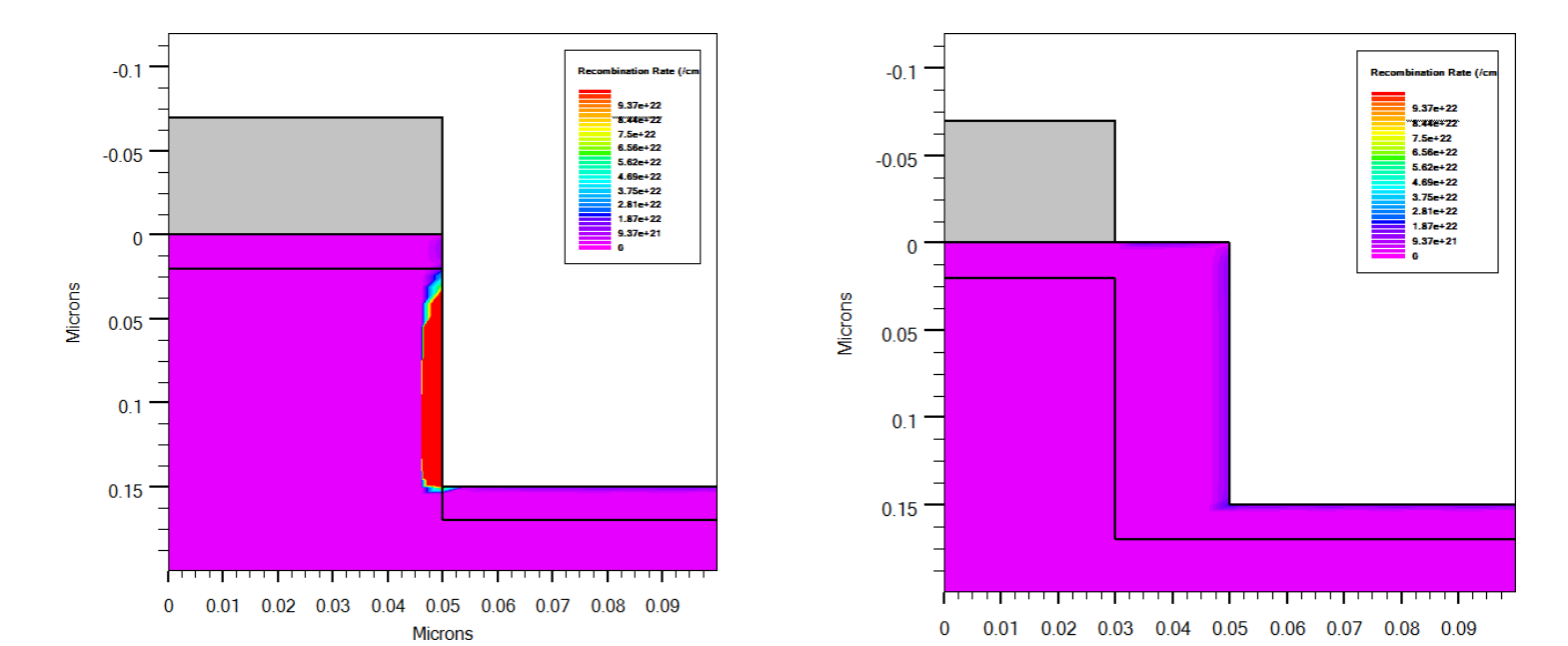
- larger absorption in underlying material
- remaining absorption around holes : need for a good surface passivation

### Electrical properties

#### Electric field

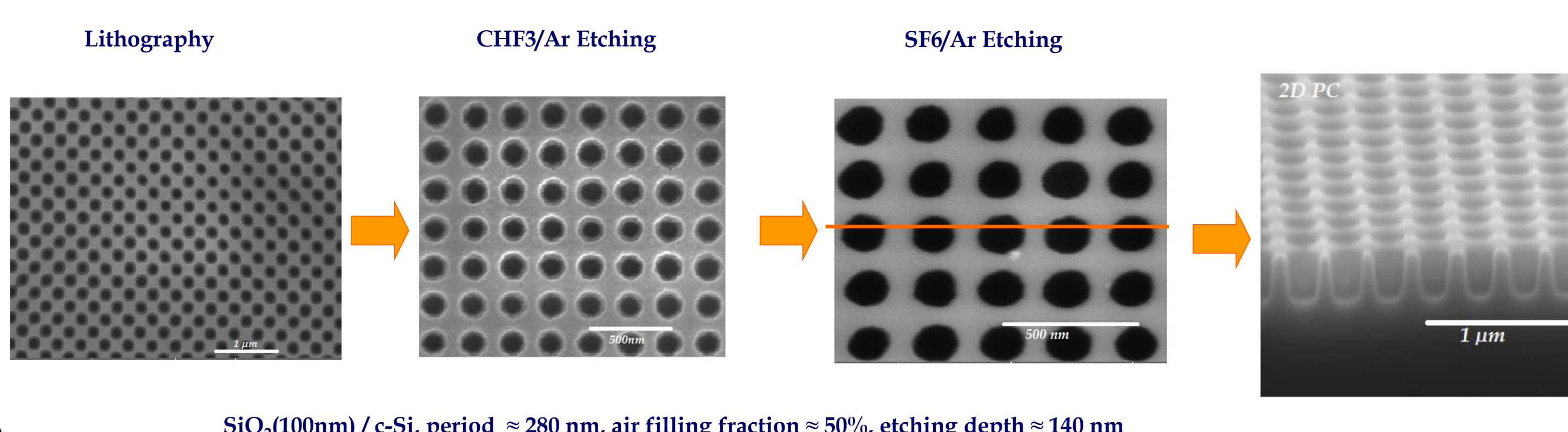


#### Recombination rate



## Fabrication

### Laser Interference Lithography, Reactive Ion Etching



## Conclusion - Perspectives

### • Enhancement of the absorption

- in the blue: light channeling, need for a good surface passivation
- In the red: strong coupling of the incident light into the Bloch Modes. Further enhancement by increasing the spectral density of modes, e.g. by introducing disorder ( cf "Absorption Enhancement in Disordered Photonic Crystals: A Photonics Point of View" - R. Peretti *et al.*)

- Fabrication of ~1 cm<sup>2</sup> 2DPC structures using laser lithography, RIE