Enhanced emission in self assembled photonic crystals by hybrid photonic-plasmonic modes

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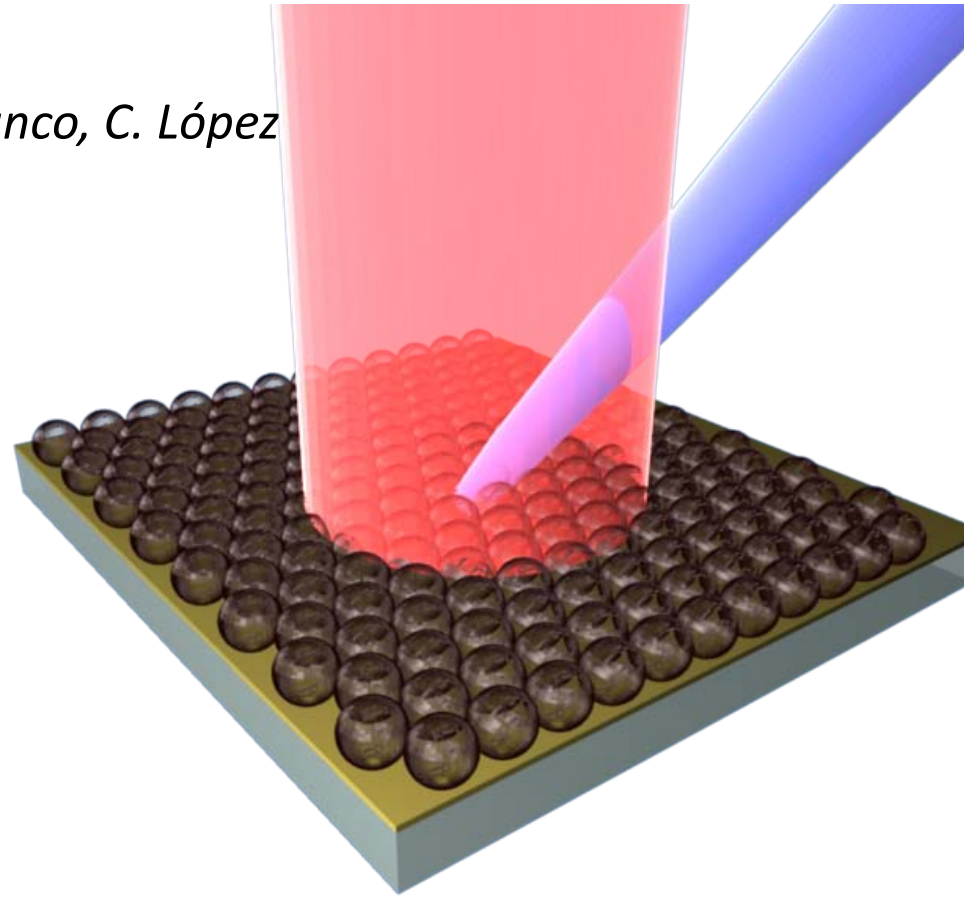
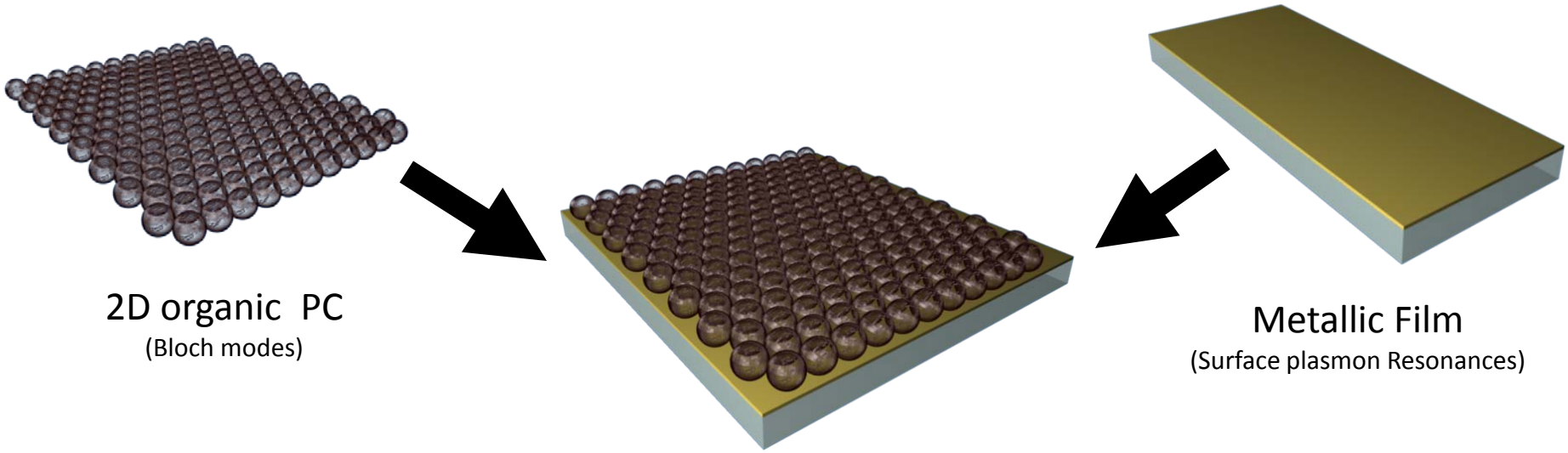


Goal and Outline

Mixed Plasmonic Surface Resonances (SPR) and 2D self-assembled photonic crystal (PC)

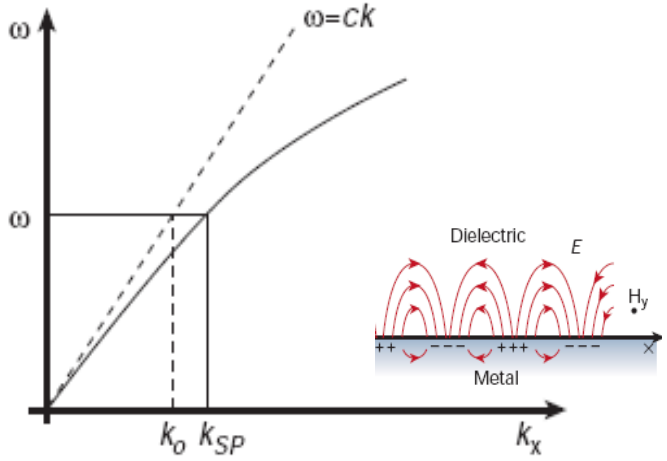


2D organic PC
(Bloch modes)

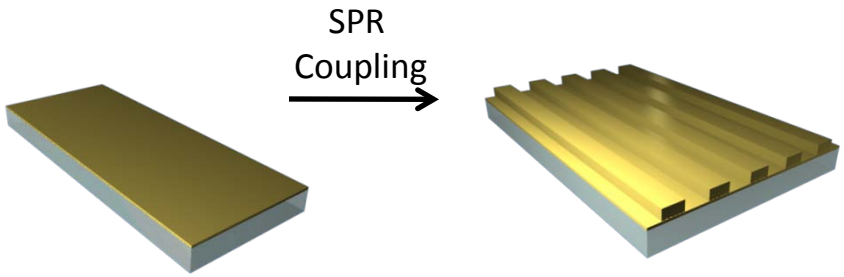
Metallic Film
(Surface plasmon Resonances)

Emission enhancement at controlable wavelenght with polarization and angular dependance

Introduction : Surface Plamon Resonances

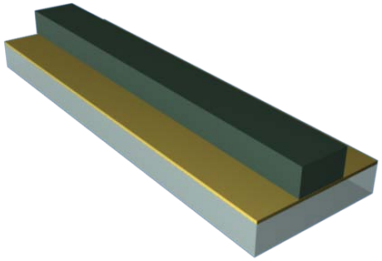


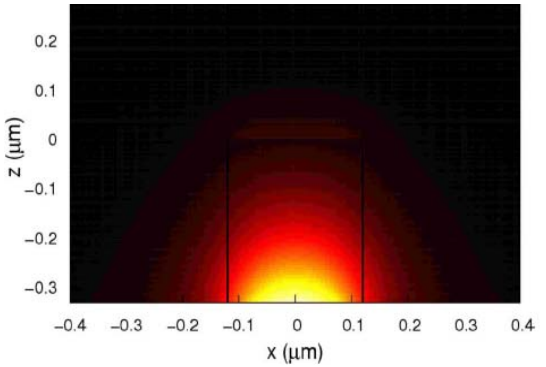
SPR
Coupling



Barnes, W.L., A. Dereux, and T.W. Ebbesen, *Surface plasmon subwavelength optics. Nature, 2003.* ***424(6950): p. 824-830.***

SPR Dielectric Waveguided Loading





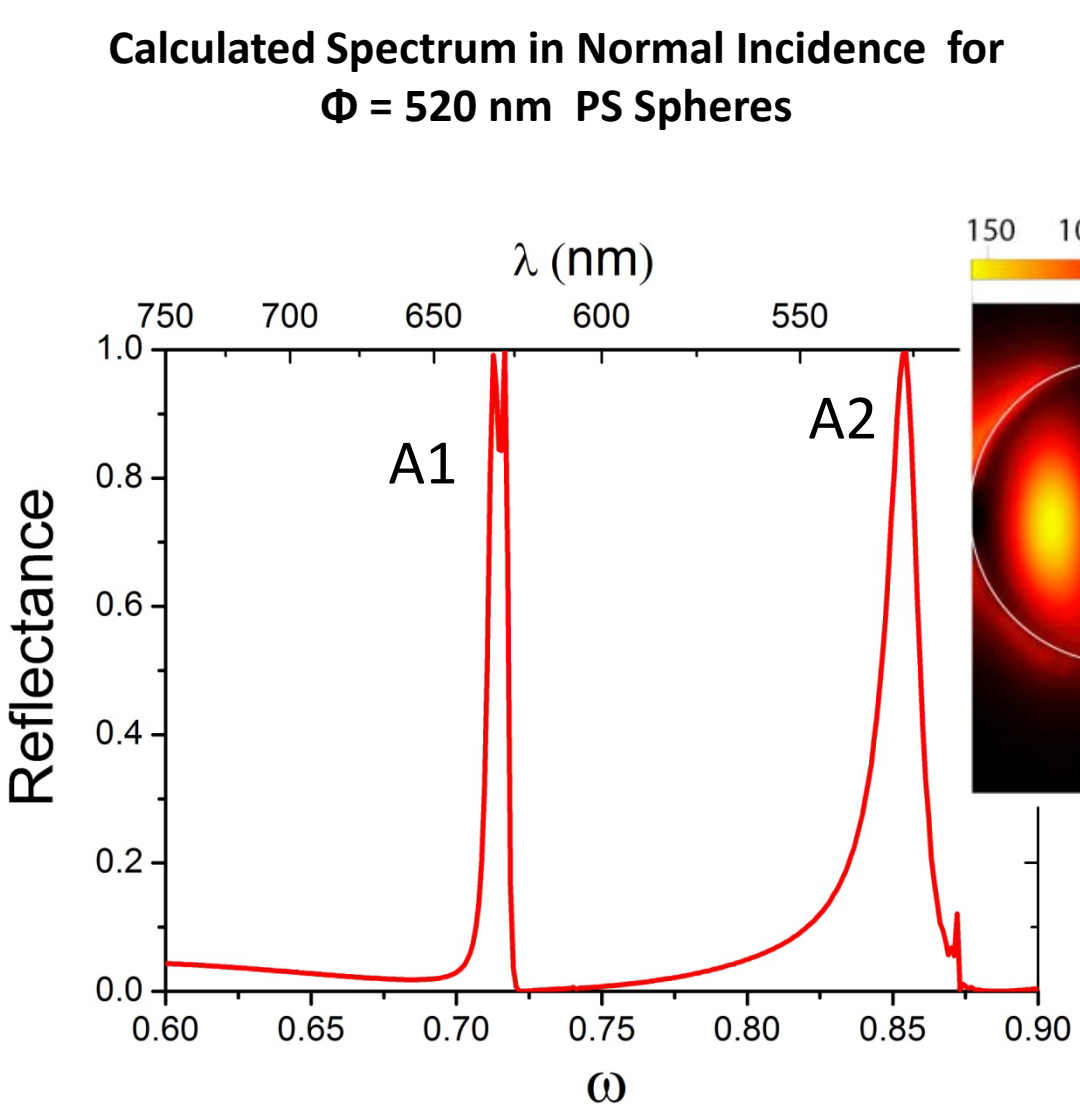
Still High field enhancement in short distance

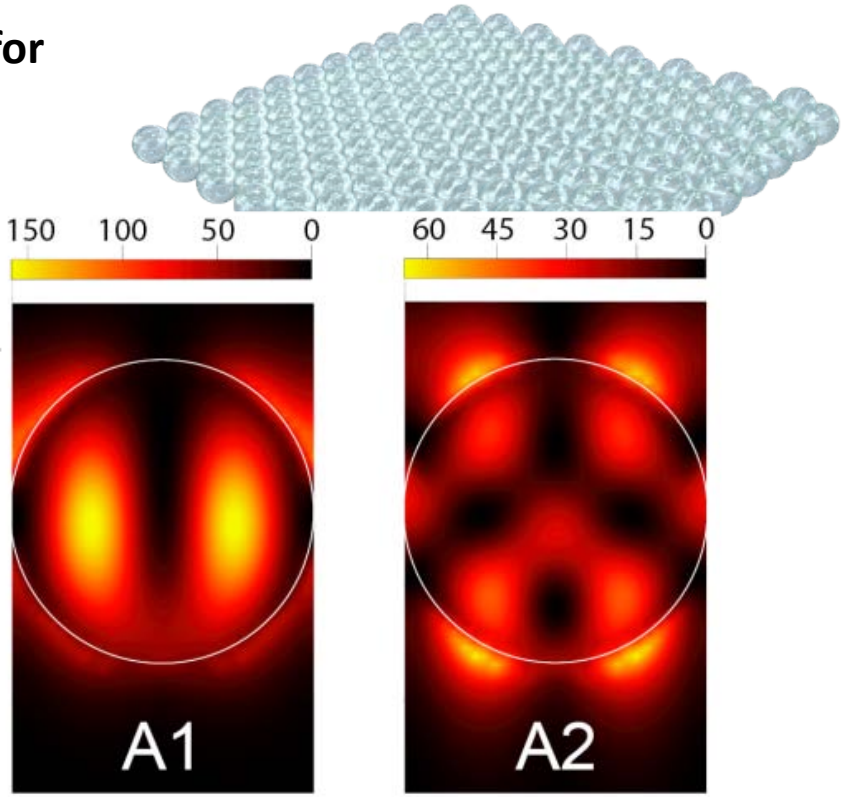
Large propagation compared to free SPR

Grandidier, J., et al., *Physical Review B (Condensed Matter and Materials Physics), 2008.* ***78(24): p. 245419.***

Introduction : Free Standing 2D PC

Calculated Spectrum in Normal Incidence for
Φ = 520 nm PS Spheres



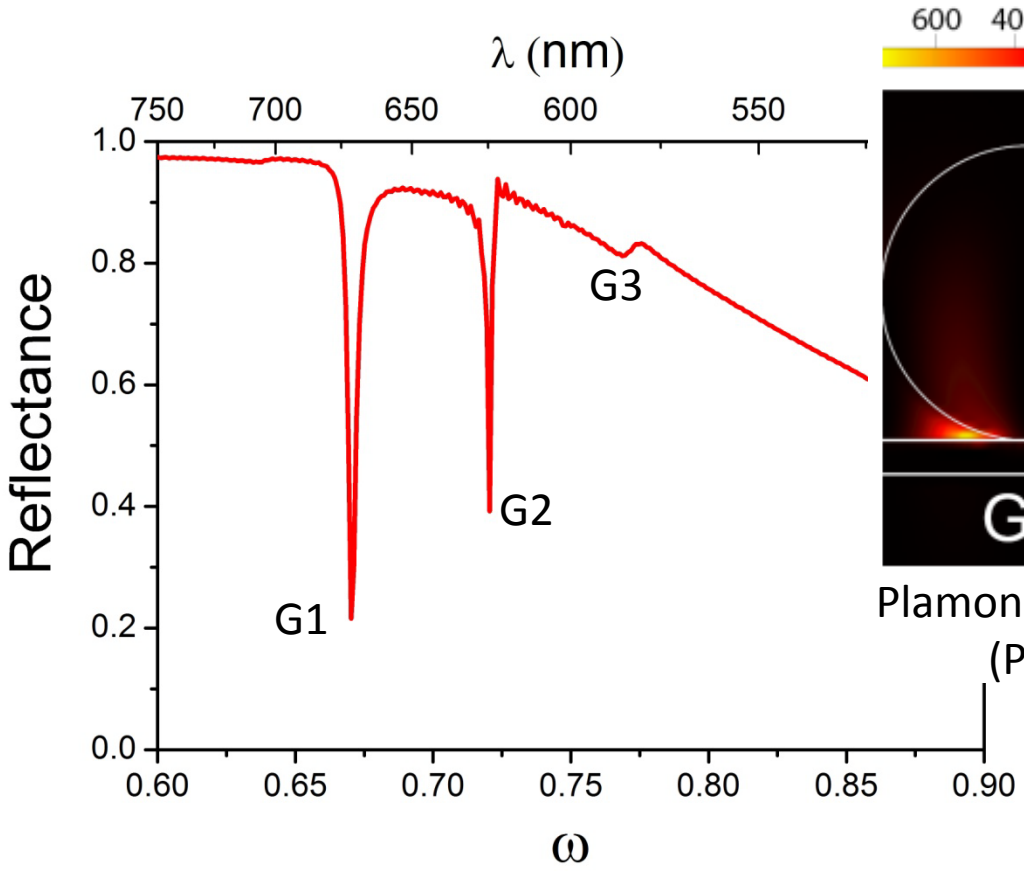


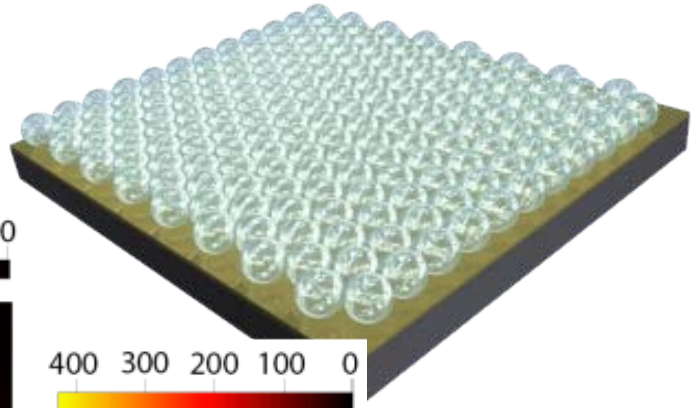
Large mode confinement with low refractive index contrast but ….

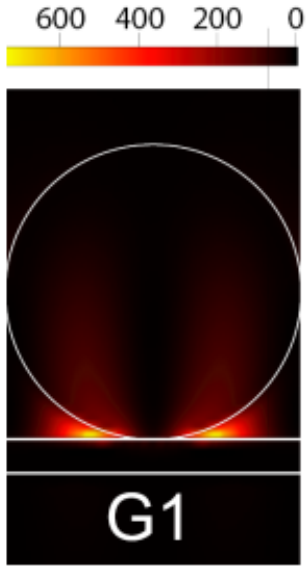
Impossible efficient implementation

Mode Coupling : Normal Incidence

Calculated Reflectance for Φ = 520 nm PS Spheres @ Gold 60 nm film

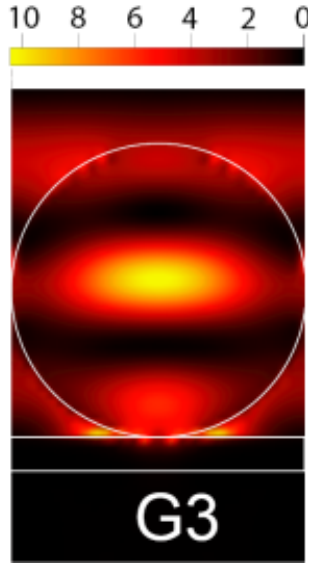






Plamonic – Like (PS)

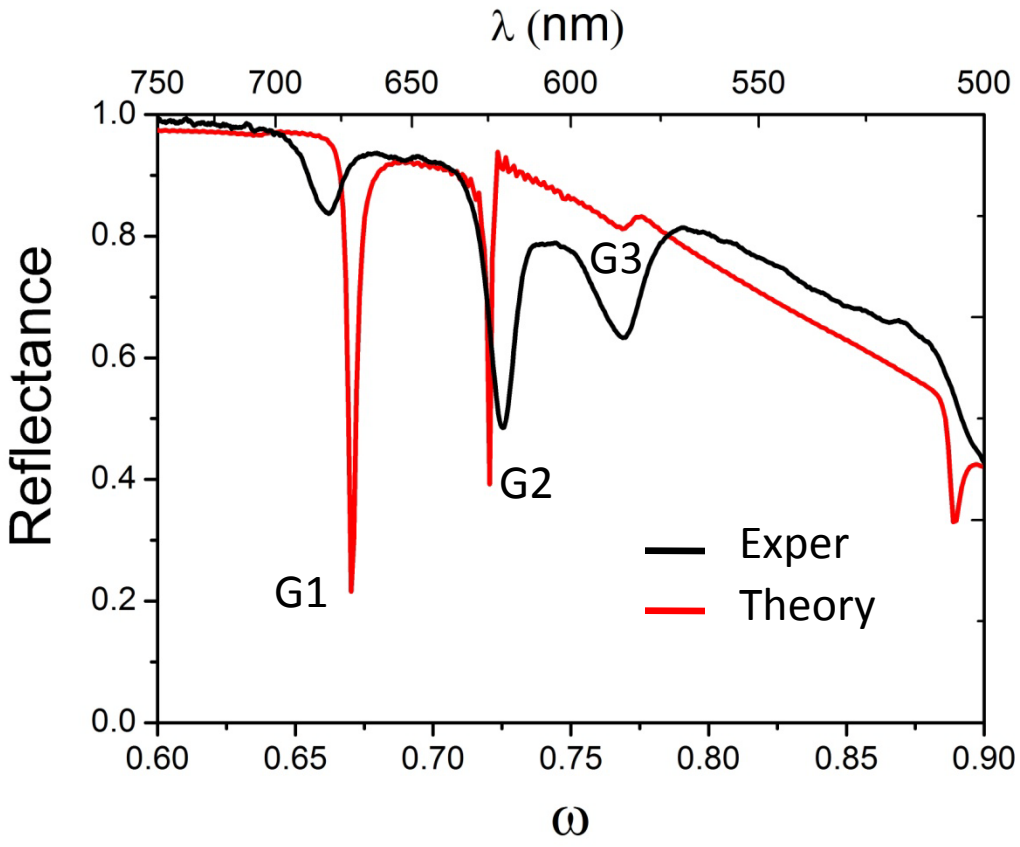
Waveguide–Like (WG)

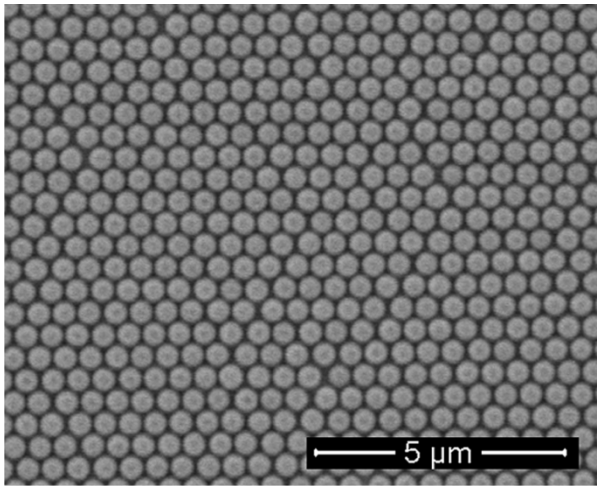


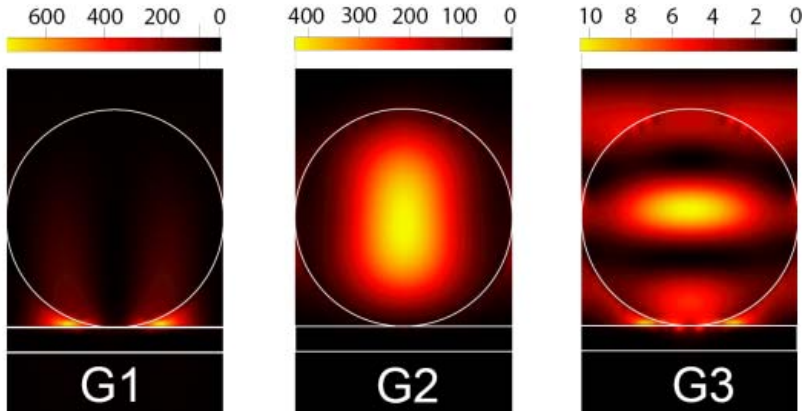
Hybrid

Mode Coupling : Normal Incidence

The Sample : **Φ = 520 nm Red Dye doped PS spheres grown on 60 nm Au film sputtered on Silicon Substrate.**



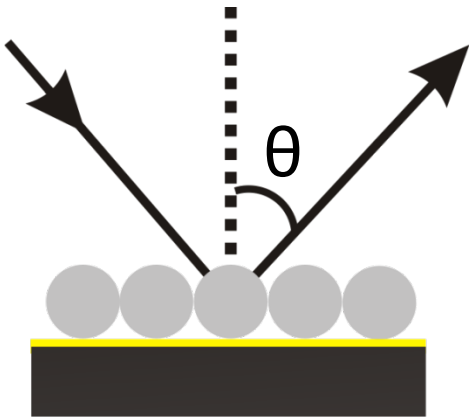




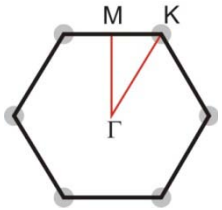
-Large mode intensity / confinement
-Easy fabrication Method
-Large Area / High Quality Samples

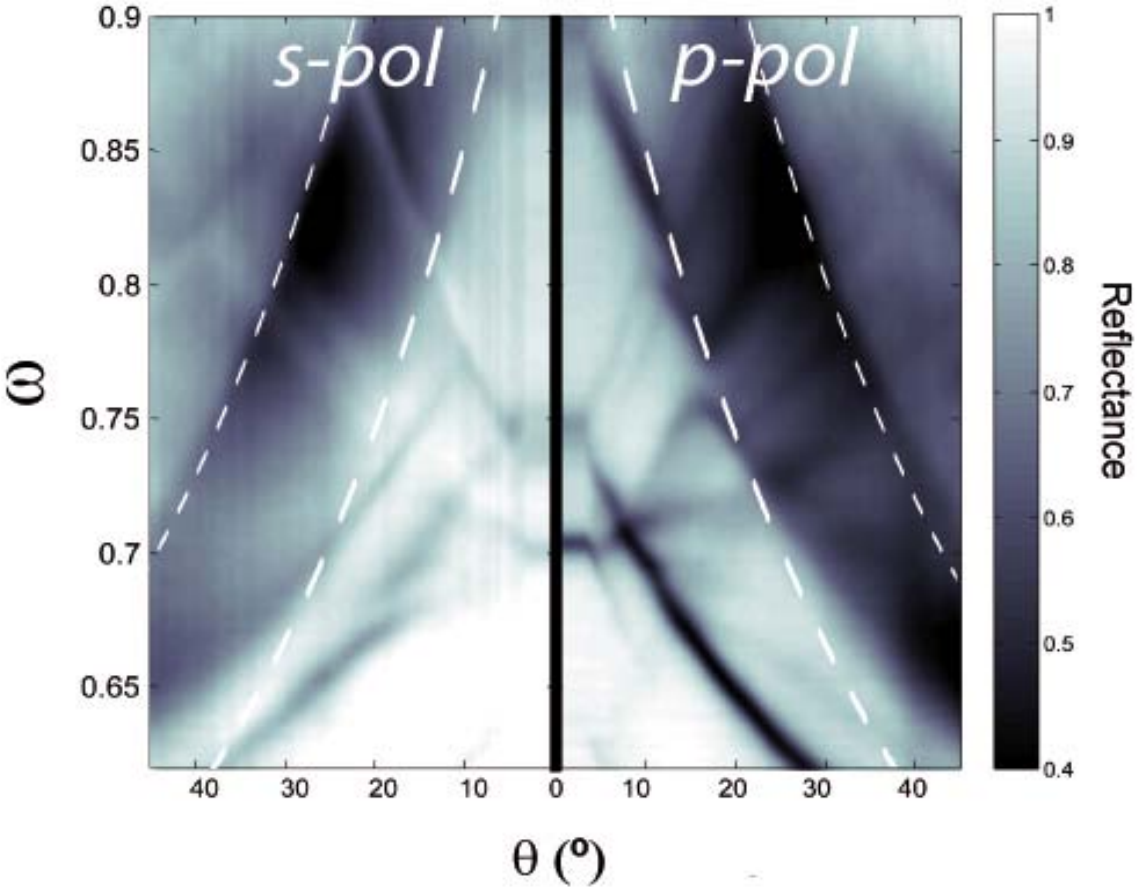
Mode Coupling : Angular Response

- -High modal dispersion
- -Polarization Dependance
- -Mode Anticrossing
- -Diffraction limit losses

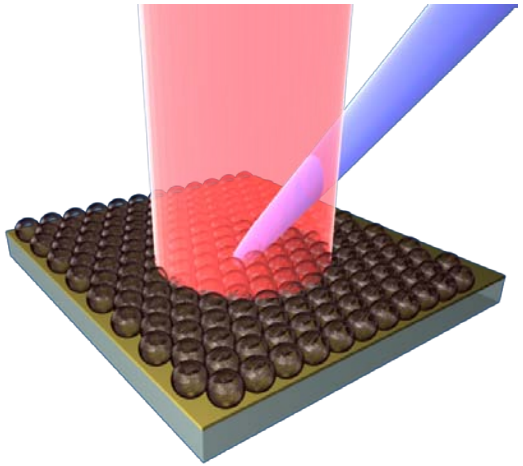


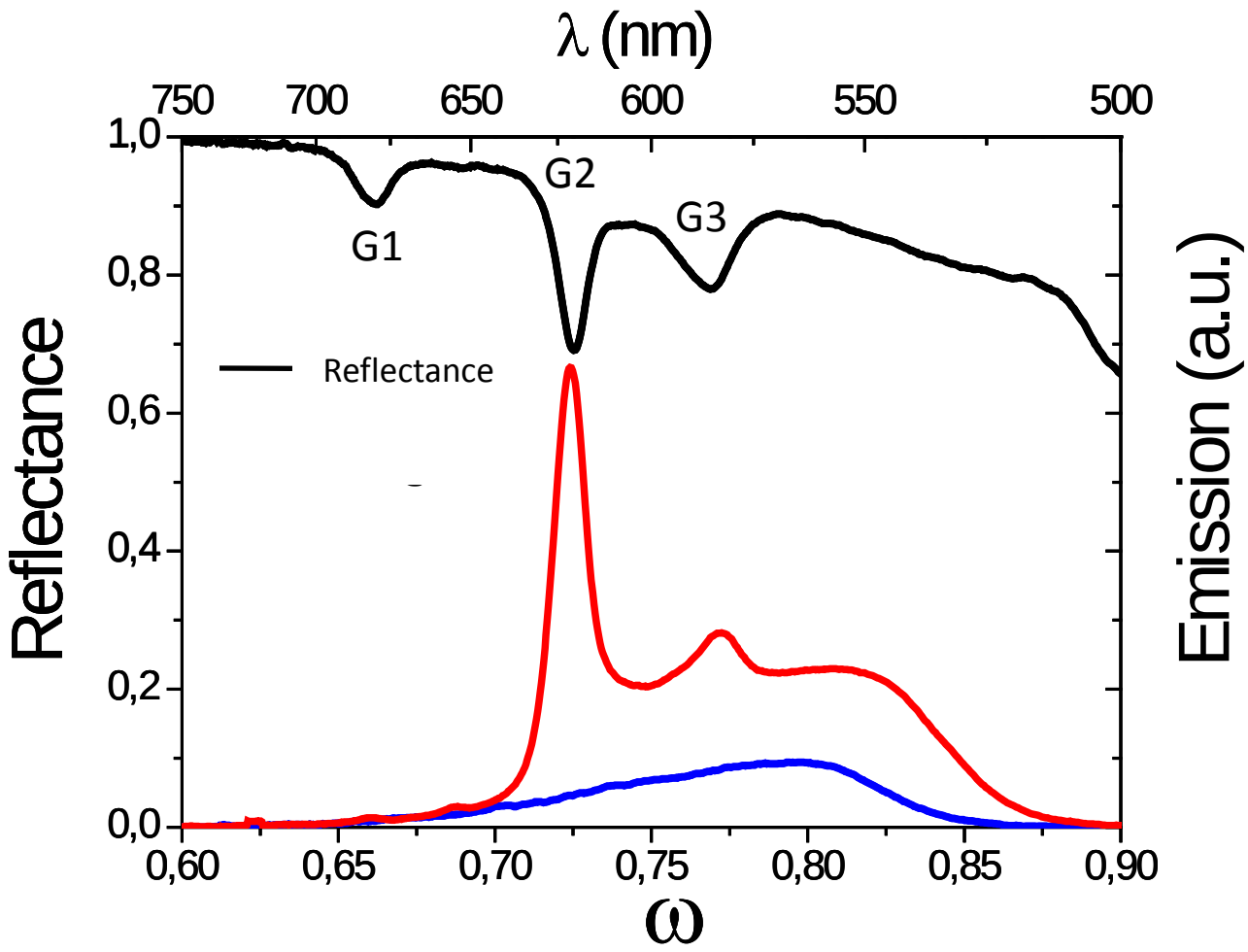
ΓK direction





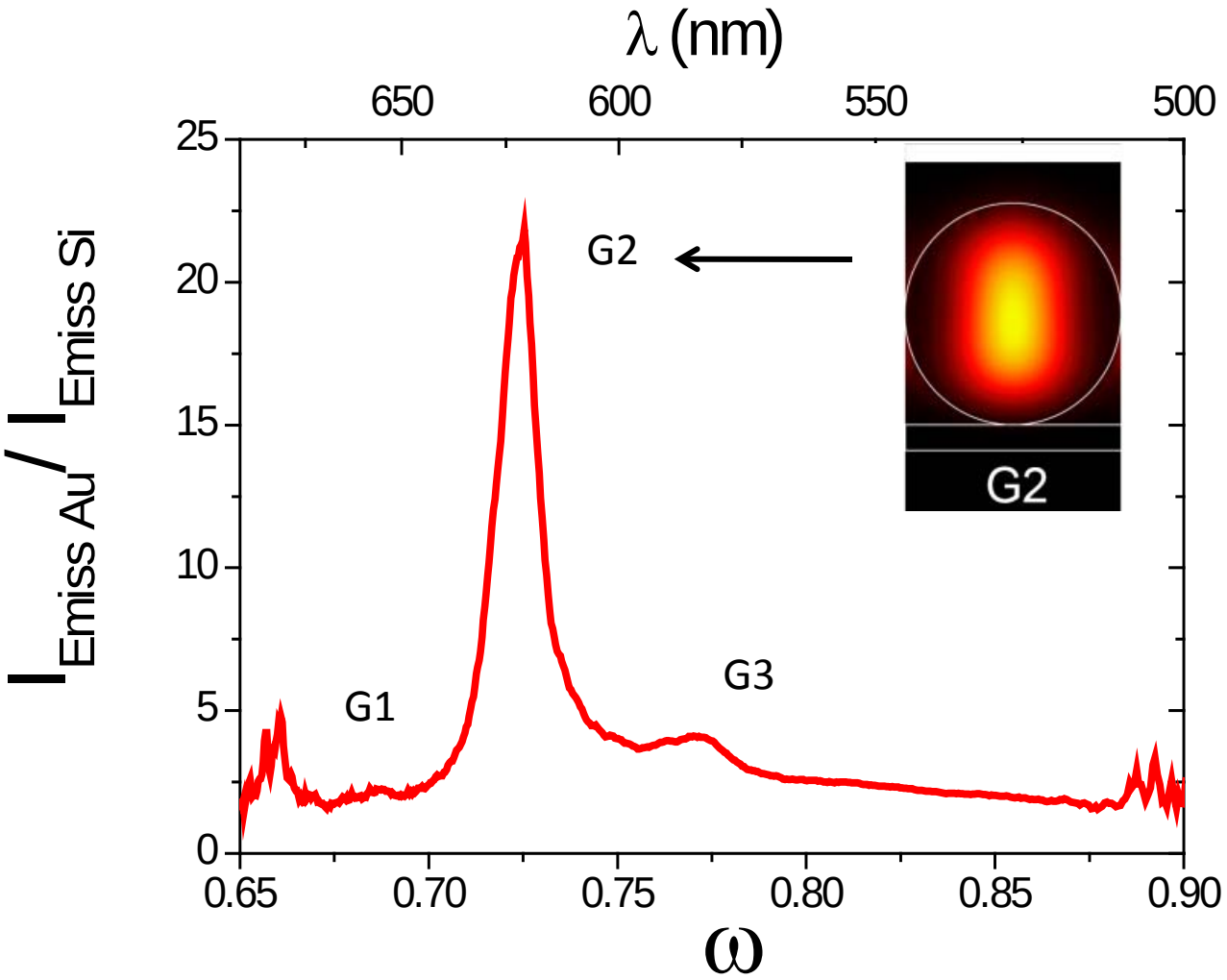
Emission Enhancement





Emission Enhancement

Emission ratio for emission of the same PC (Φ = 520 nm) on Au and Si substrate

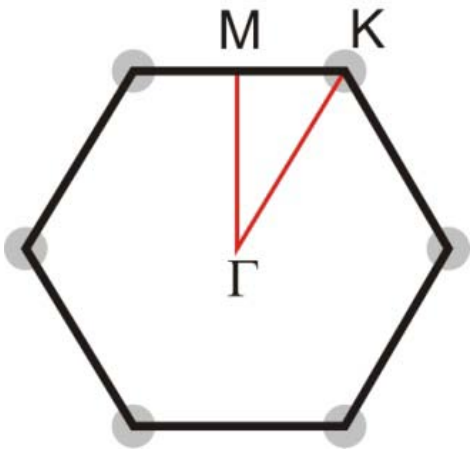


Emission Enhancement : Angular Distribution

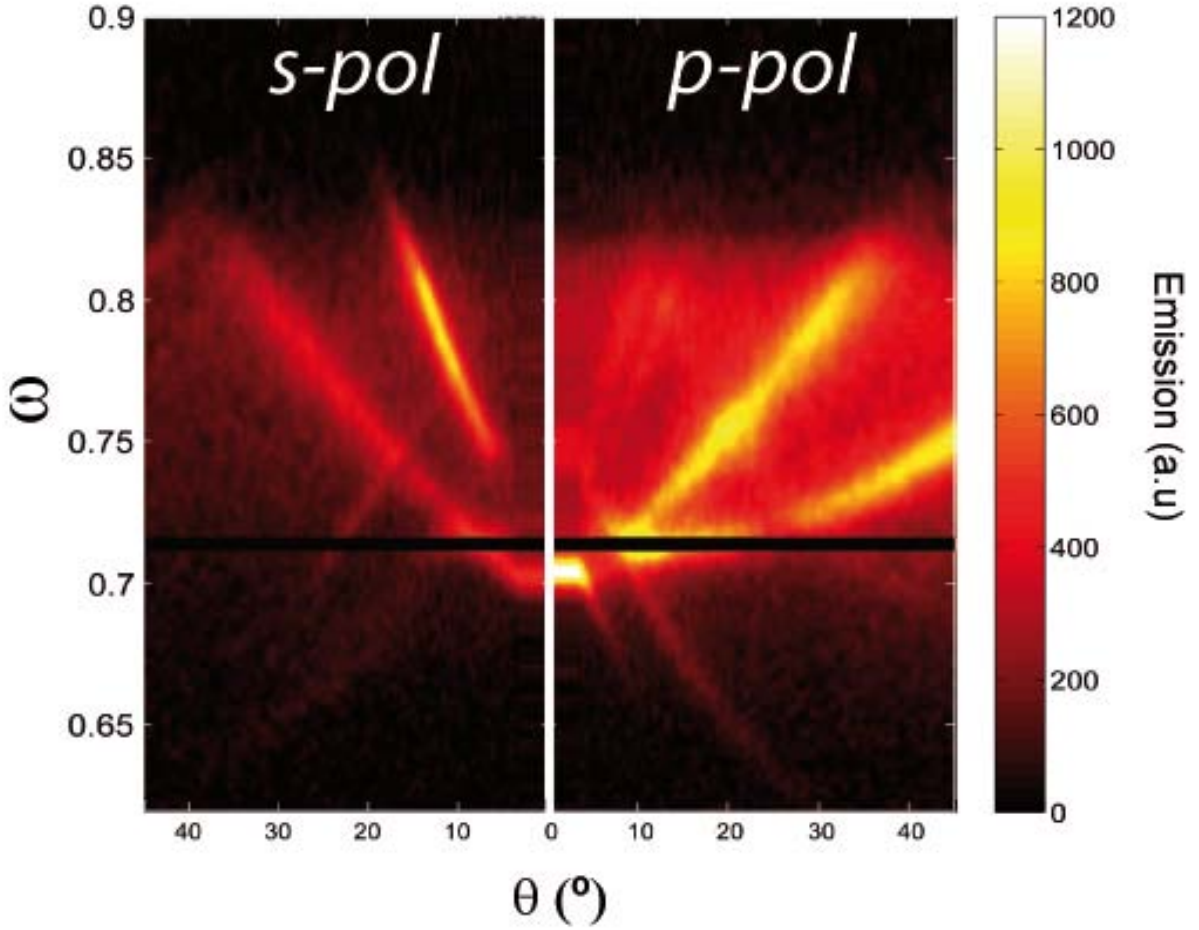
-Large Enhancement

-Angular Distribution

-Polarization dependace

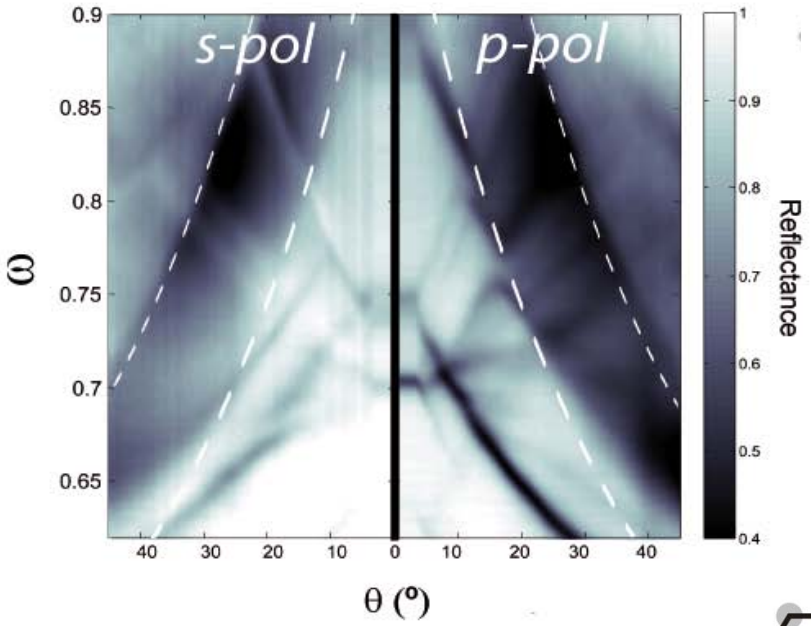


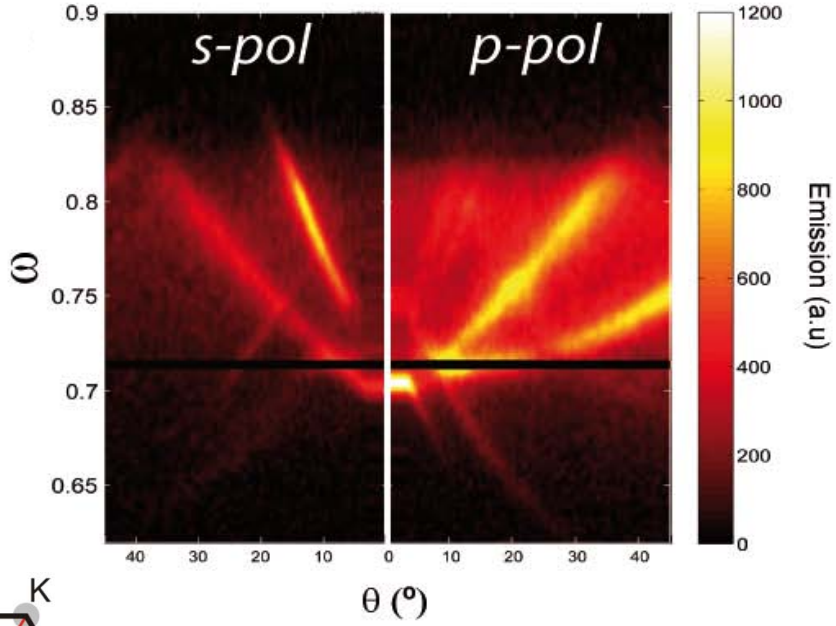
ΓK direction

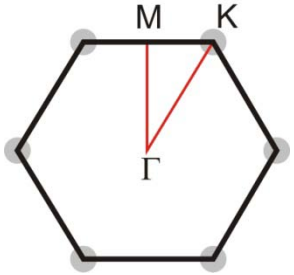


Emission Enhancement : Angular Distribution

ΓK direction







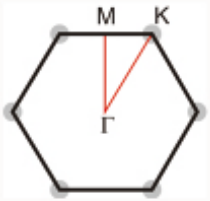
Angular Emission at one single ω

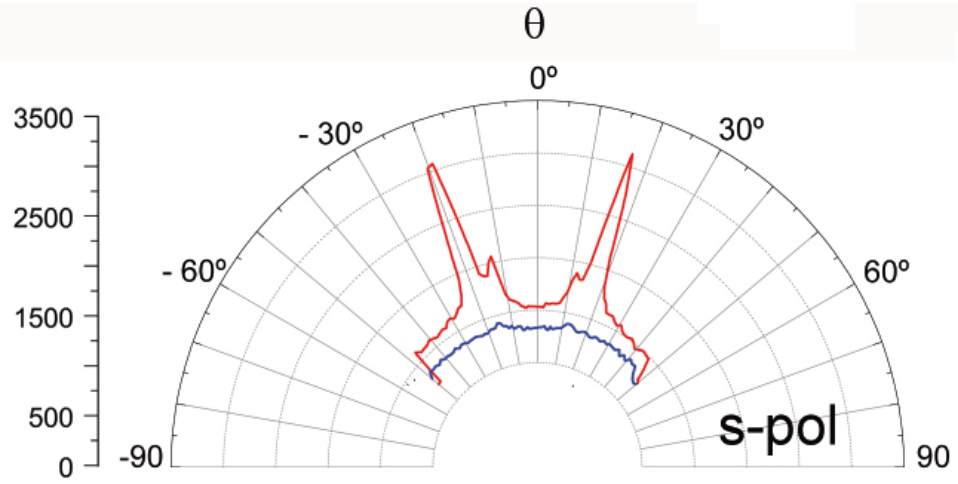
$\omega = 0.8$

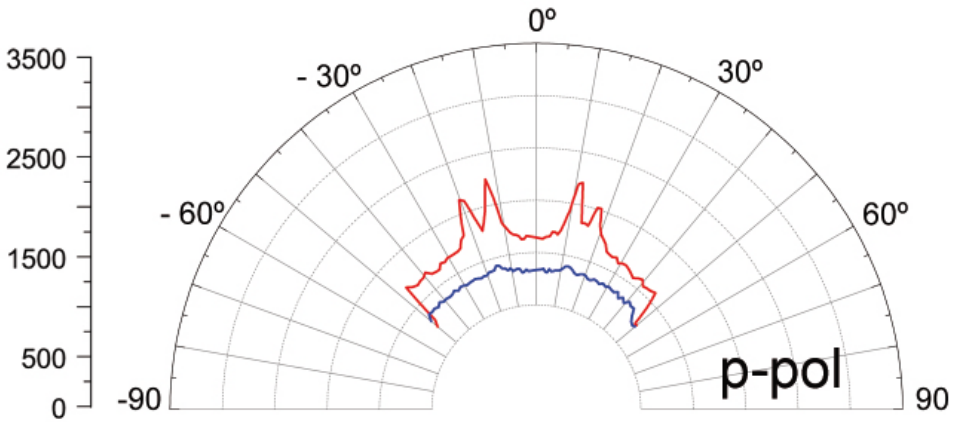
Au subs

Si subs

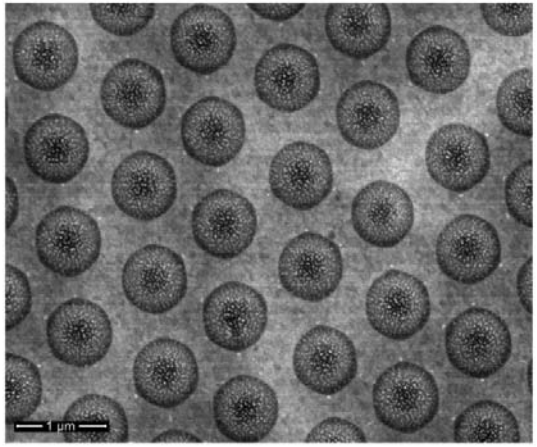
ΓM direction

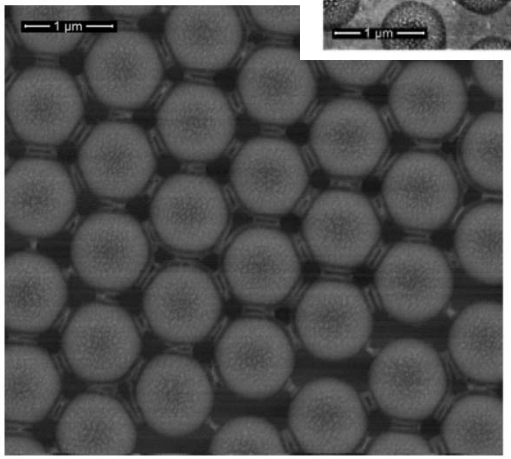


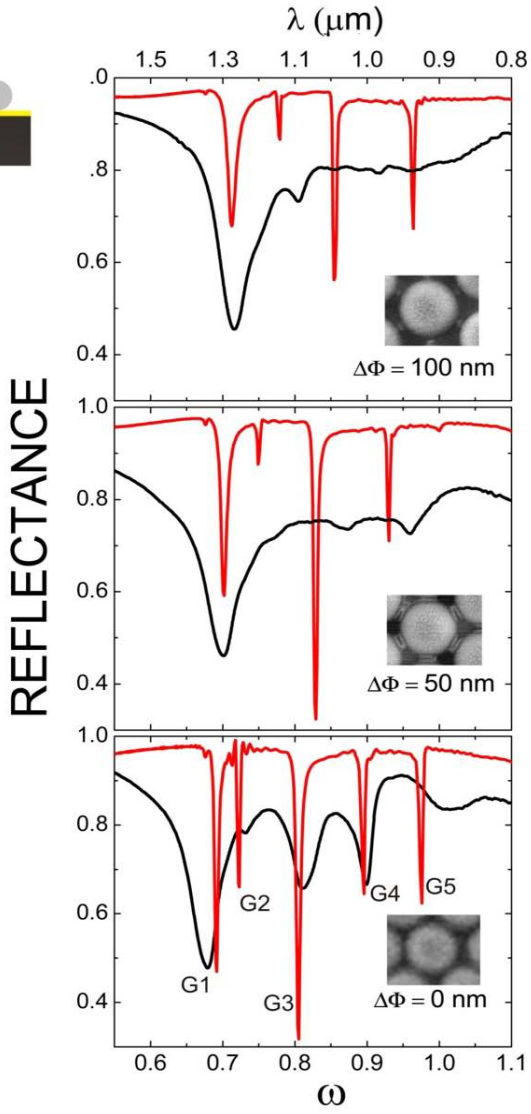


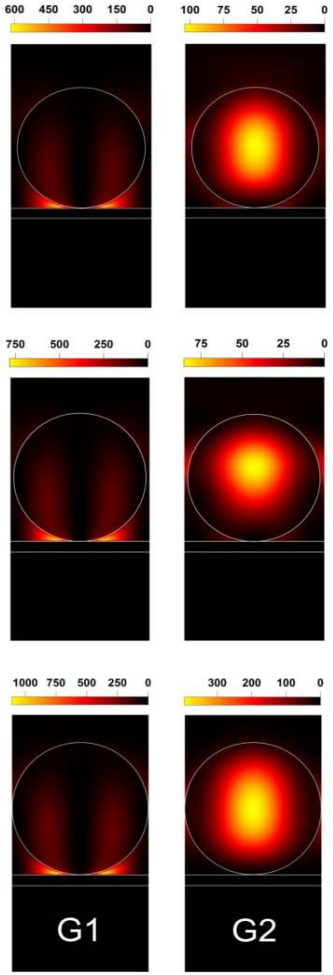


Future Work : Tailoring modal distribution









Conclusions

PS monolayers @ Gold substrate are suitable to obtain :

-**Easy fabrication & Large area** photonic-plamon crystals.
-**Easy Coupling** to both plasmon and photonic–like modes
-**Tunable dispersion relation** by sphere diameter right choose

If used dye dopped spheres it i spossible to get :

-**Large Emission Enhancement** at wavelenghts matching a mode

-**Controll over polarization and angular distribution** of the emission.

Possible aplications : Low cost devices for OLED technology or sensing

Acknowledgements

Our Group :

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Programa FPI