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Applications of Spectrophotometry in Emerging Nanomaterials

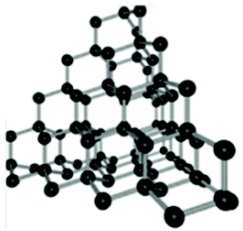
Li-Lin Tay, John Hulse, Shawn Poirier, Ali Ghaemi and Jeff Fraser

Metrology Research Centre, National Research Council Canada, Ottawa ON

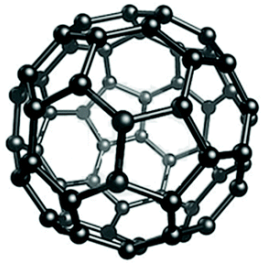
Council for Optical Radiation Measurements (CORM 2019) Ottawa, ON Oct. 29th , 2019

EMERGING NANOMATERIALS

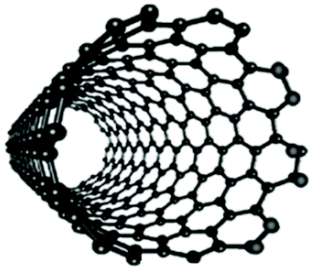
Emerging Nanomaterials



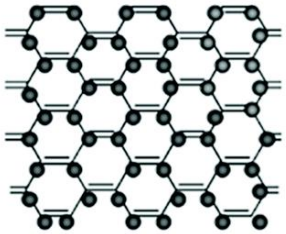
Diamond



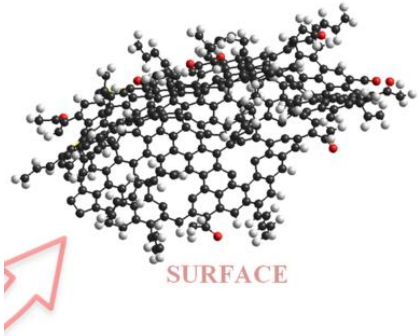
Fullerene

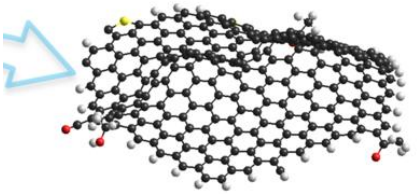


Carbon nanotube

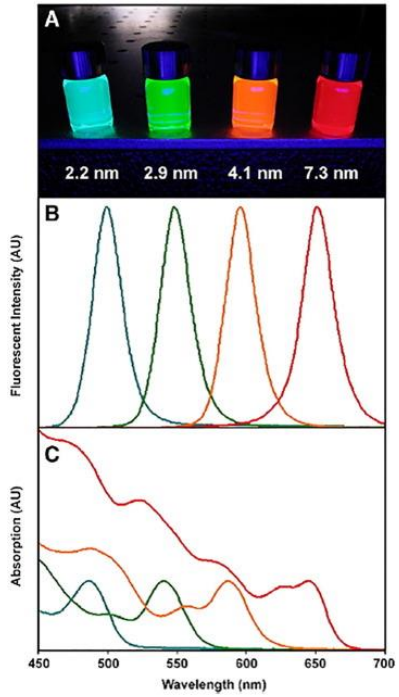


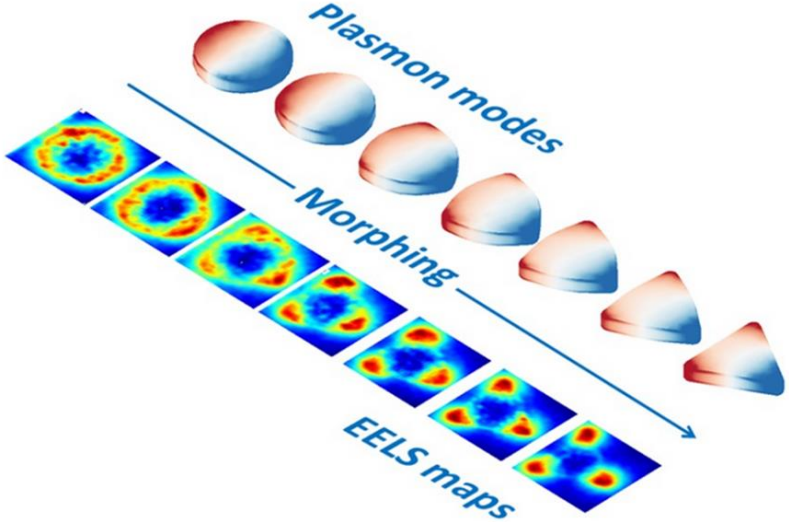
Graphene





soot crystallite
0.5-5 nm

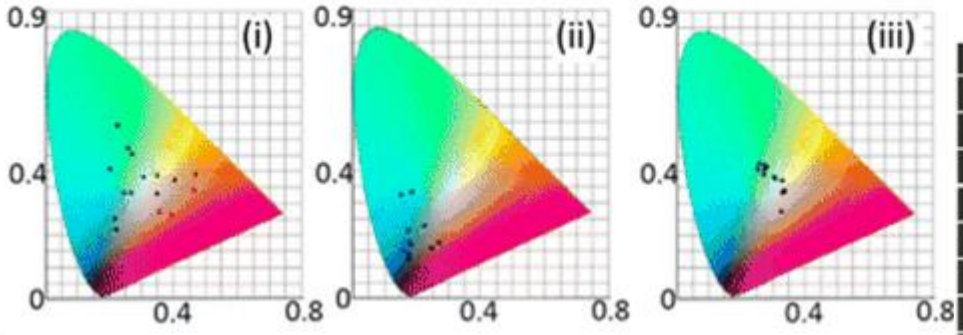




Applications of Plasmonic Nanostructures: Plasmonic Colour

d

Lu et al., Opt. Lett., 41, 1400, 2016



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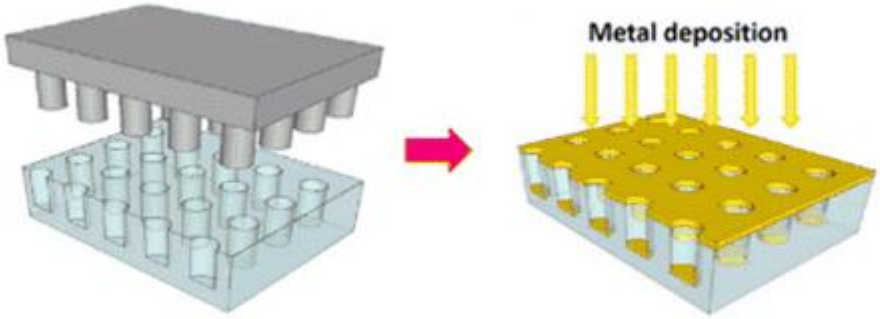

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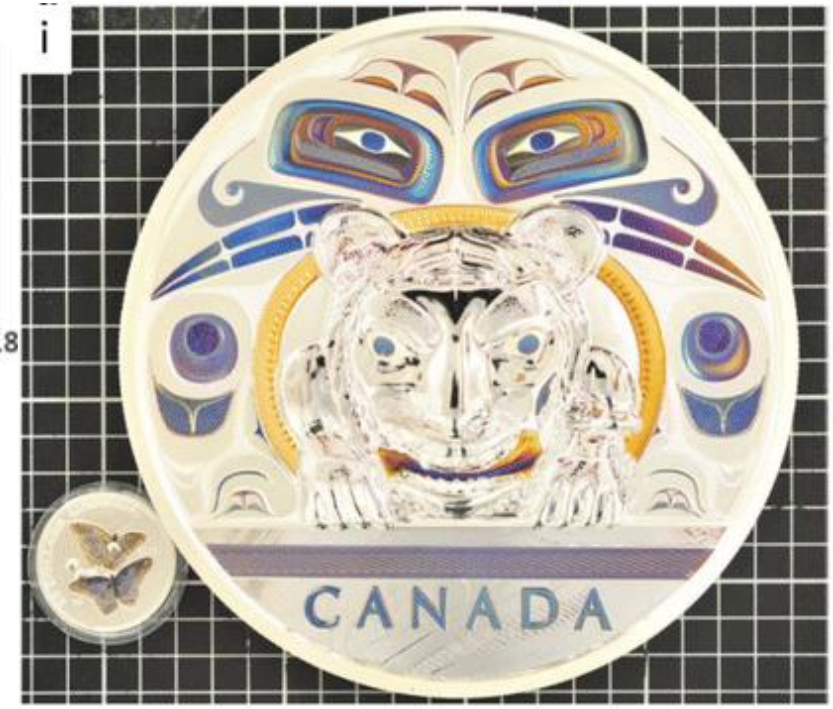
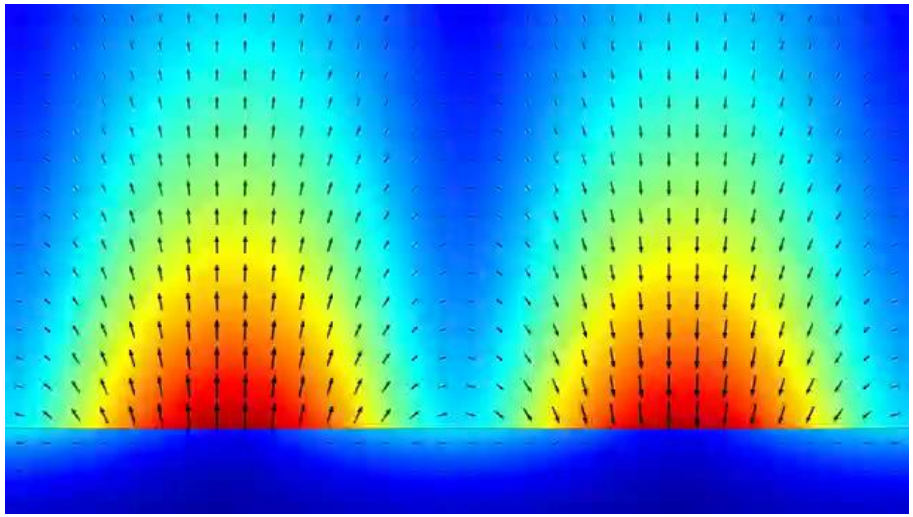
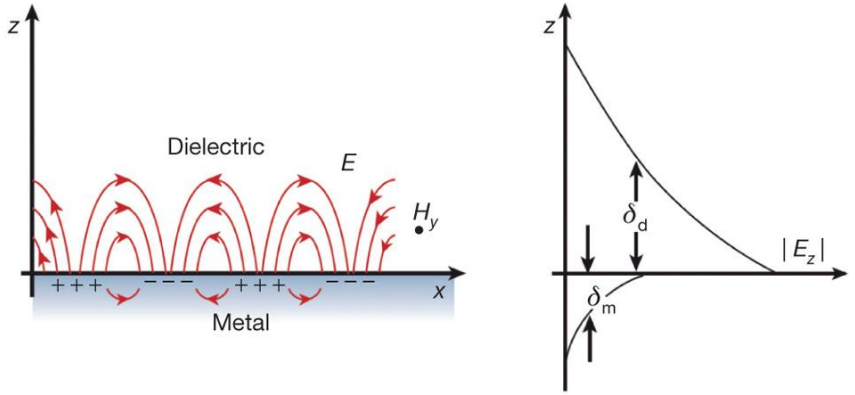


Plasmonic Sensors

Surface Plasmon Polariton

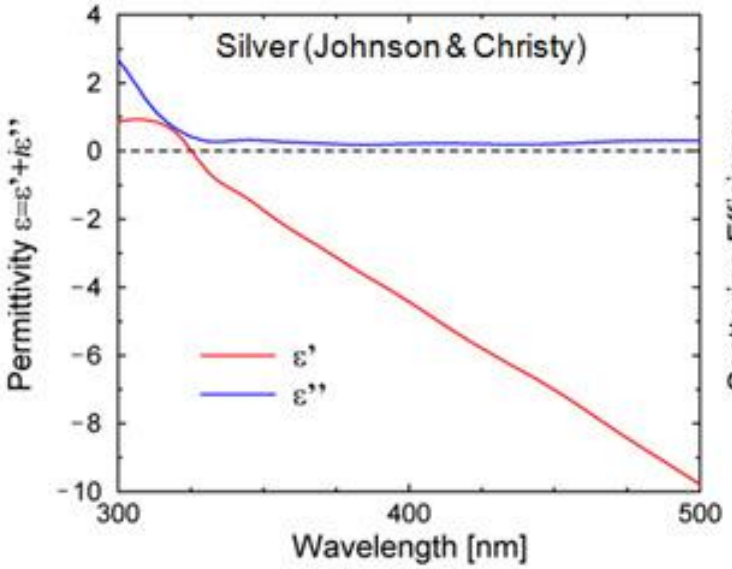


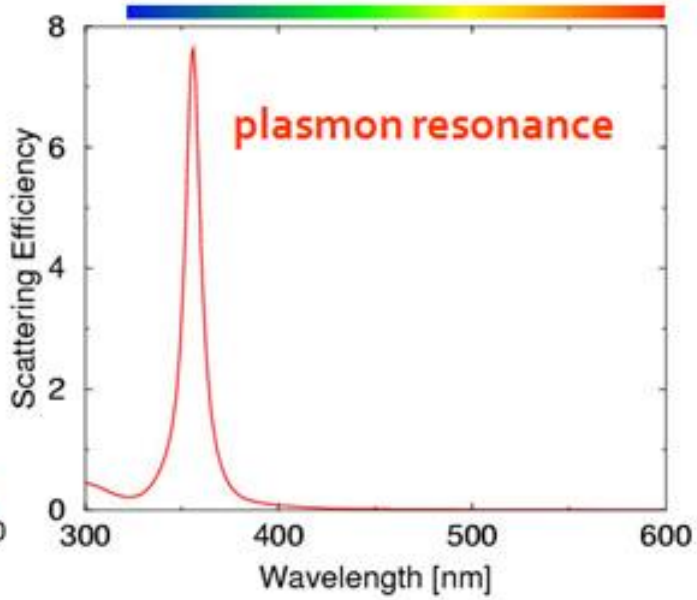


Localized Surface Plasmon Resonance (LSPR) - Ag Nanoparticles

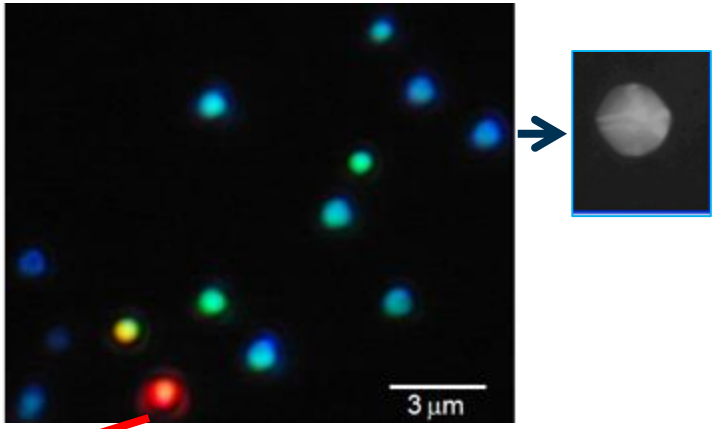
Scattering efficiency: $Q(\lambda) = \frac{8}{3} x^4 \left| \frac{\varepsilon(\lambda) - 1}{\varepsilon(\lambda) + 2} \right|^2$

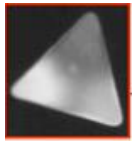
$x = 2\pi R / \lambda$



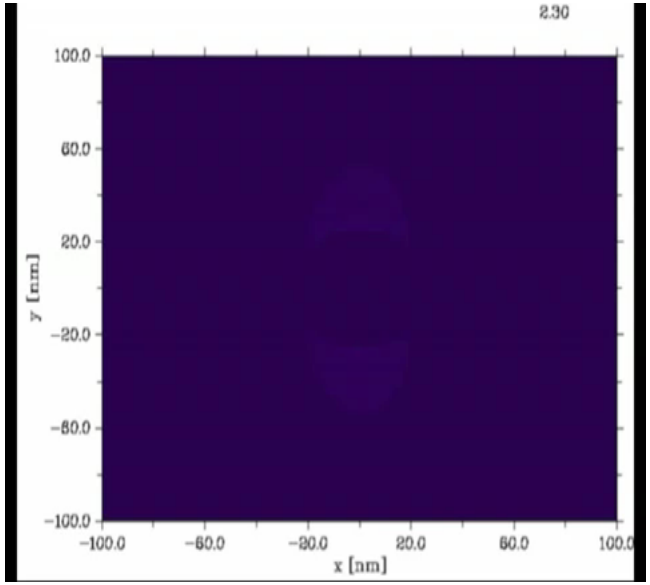


Plasmonic Nanostructures





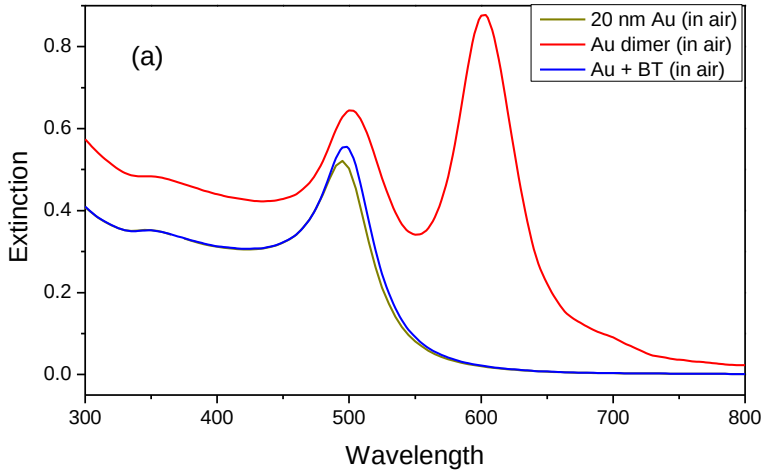
Rayleigh scattering images of dispersed Ag NPs

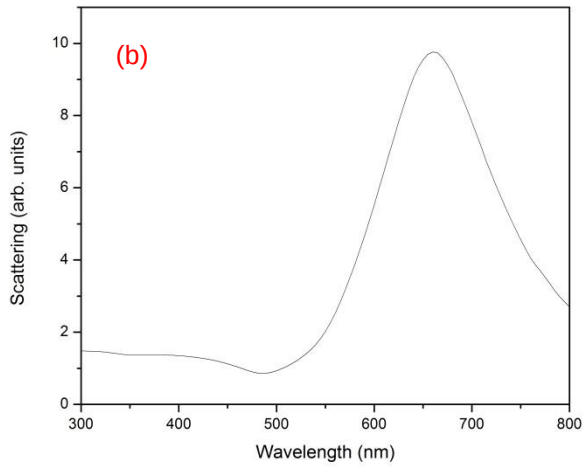


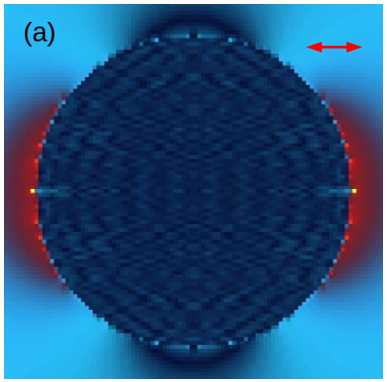
Silver nanoparticle excited by an electromagnetic plane wave at the plasmon resonance

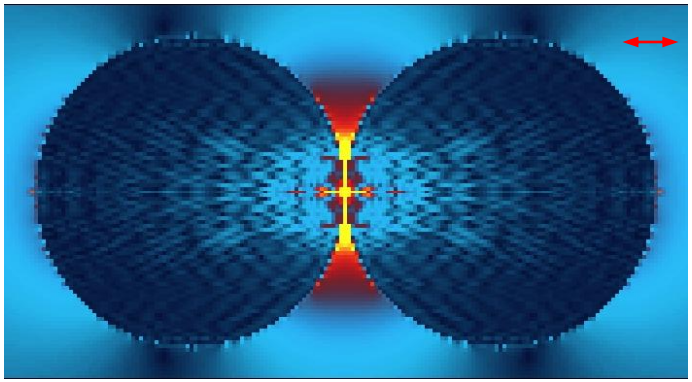
Maxim Sukharev, Arizona State University

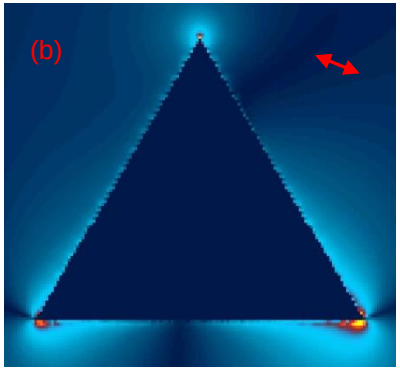
LSPR and Plasmonic Optical Antenna











|E| max = 7

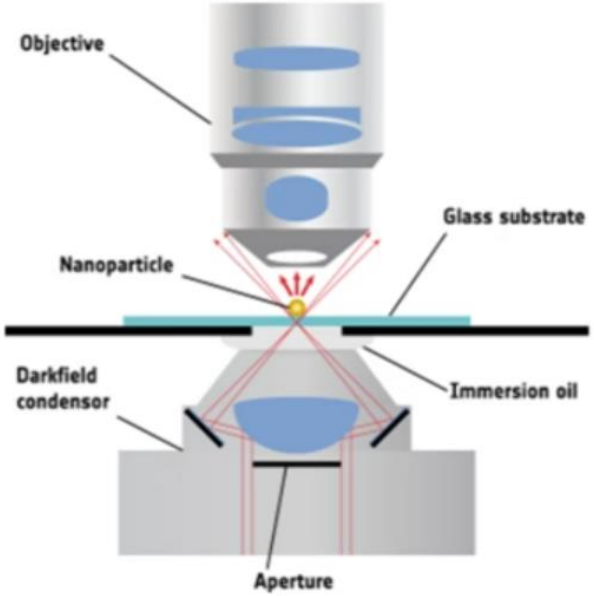
Gap = 1 nm

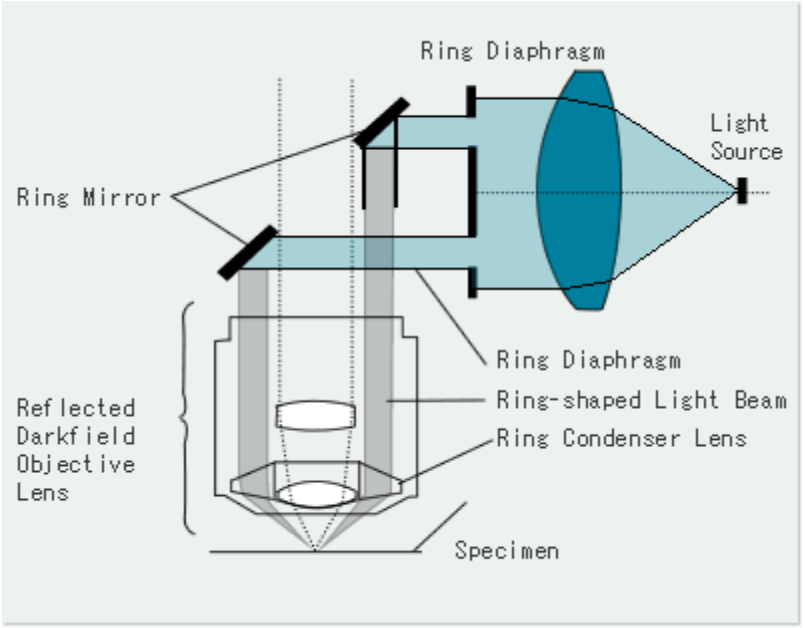
|E| max = 169

|E| max = 62

Tay et al., Noble Metal NPs in Biodetection, CRC Press, 2012, 249

Single Nanoparticle Spectroscopy





Forward Scattering

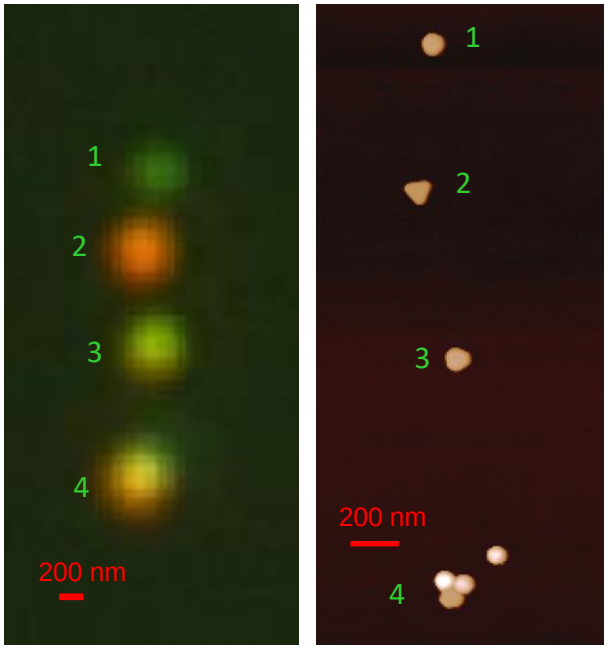
SERS

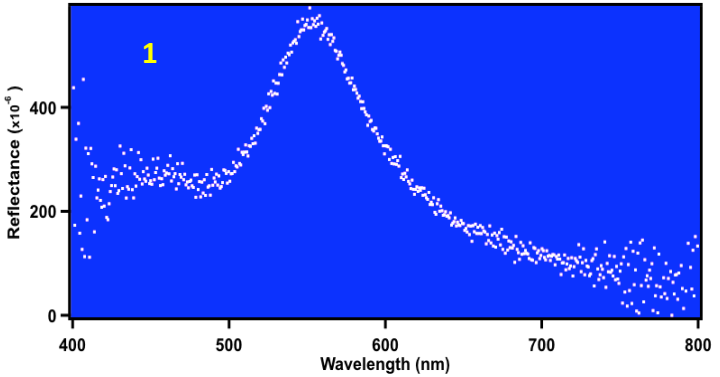
backscattering

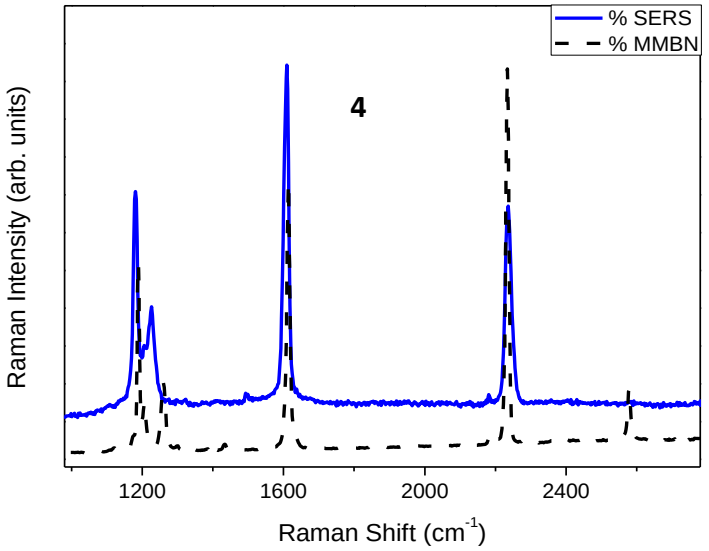
RRS

J. Phys. Chem. C. 2010, **114**, 7213

Single Nanoparticle Correlation Spectroscopy

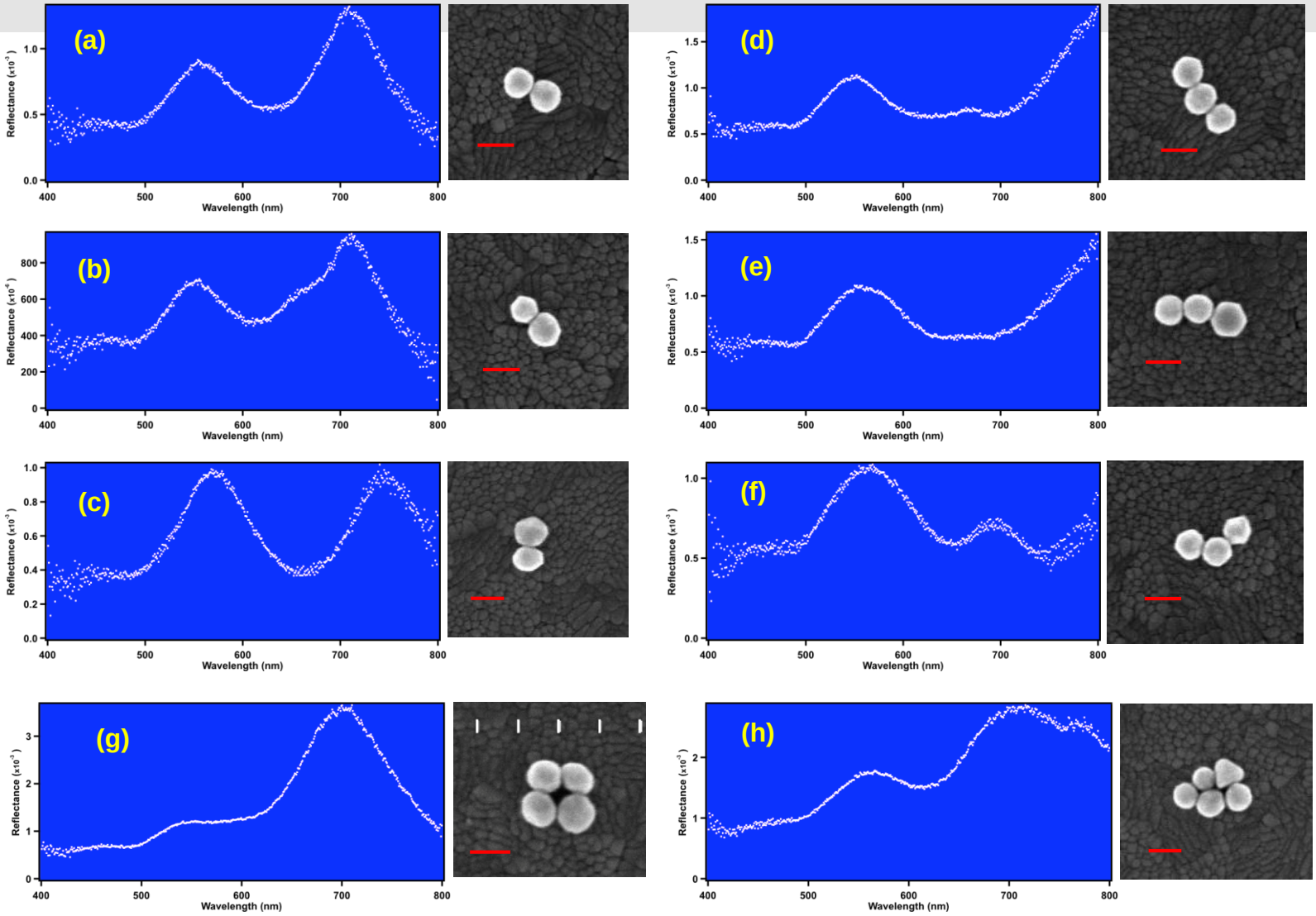






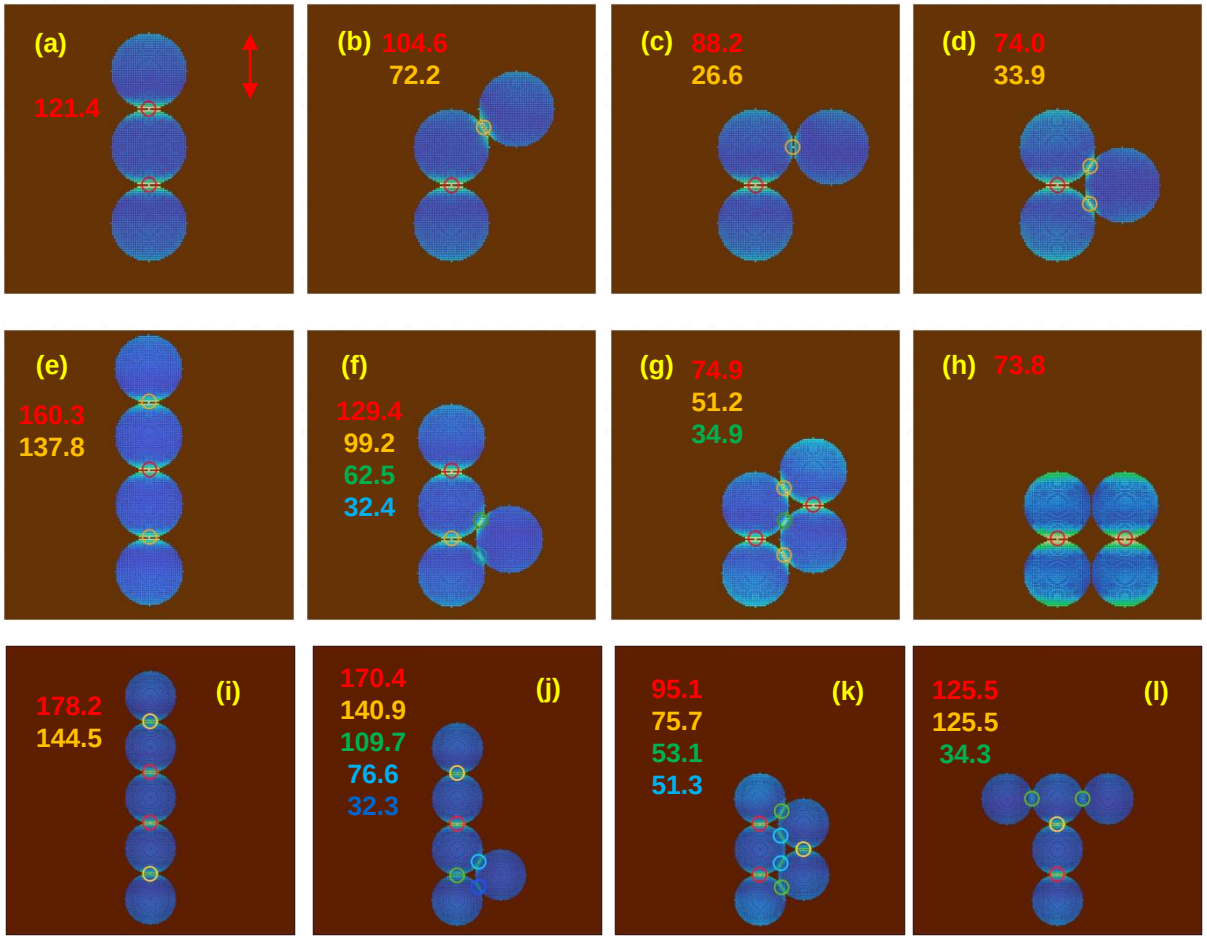
J. Phys. Chem. C. 2010, **114**, 7213

Scattering Spectroscopy of Nanoaggregates



J. Mod. Optics 2013, 60(14), 1107

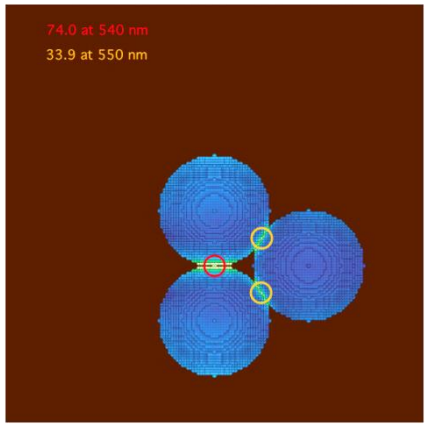
Geometric Arrangements and Local Optical Field Variations



J. Mod. Optics 2013, 60(14), 1107

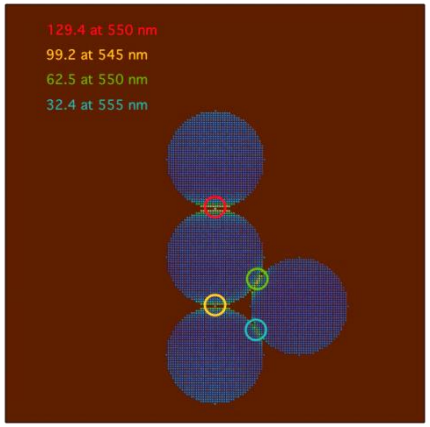
Influences of Aggregate Geometric on the Electric Field Distribution

Close-Packed



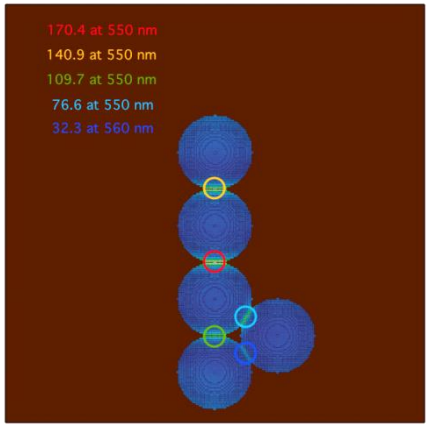
EF ~ 0.3 x 10^8

Scoop



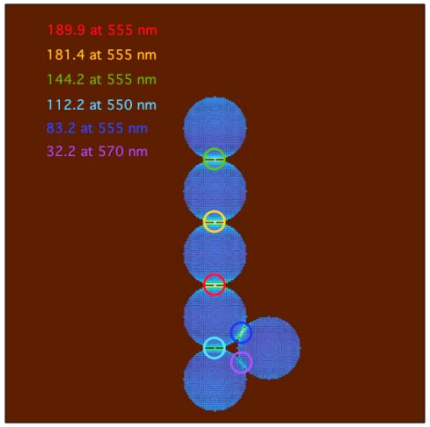
EF ~ 3.9 x 10^8

Shovel



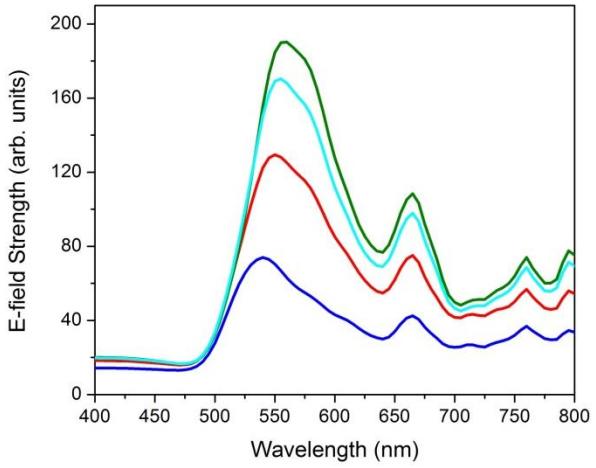
EF ~ 1.4 x 10^9

Spade



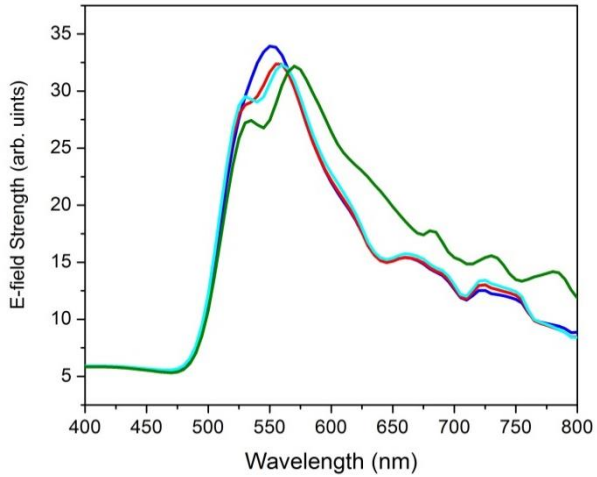
EF ~ 3.0 x 10^9

E-field @ Max



Trimer
Tetramer
Pentamer
Hexamer

E-field @ Min



Conclusion

- Developed darkfield optical micro-spectroscopy capability to enable multimodal spectroscopies of a single plasmonic nanoparticles
- Developed electromagnetic field distribution model for aggregated plasmonic nanostructures
- Optical Spectroscopies are invaluable tools for emerging nanomaterials such as nanocarbon, quantum confined nanostructures and plasmonic devices

THANK YOU

Li-Lin Tay

Photometry and Specrophotometry,
NRC-Metrology

lilin.tay@nrc-cnrc.gc.ca