Applications of Spectrophotometry in Emerging Nanomaterials

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EMERGING NANOMATERIALS
Emerging Nanomaterials

- **Diamond**
- **Fullerene**
- **Carbon nanotube**
- **Graphene**

**SURFACE**

- soot crystallite
  - 0.5-5 nm

**BULK**

**Plasmon modes**

**Morphing**

**EELS maps**

**A**

Fluorescent Intensity (AU)

**B**

Absorption (AU)

**C**

Wavelength (nm)
Applications of Plasmonic Nanostructures: Plasmonic Colour

Plasmonic Sensors
Surface Plasmon Polariton
Localized Surface Plasmon Resonance (LSPR) - Ag Nanoparticles
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

(a)

Extinction vs Wavelength for different structures:
- 20 nm Au (in air)
- Au dimer (in air)
- Au + BT (in air)

(b)

Scattering (arb. units) vs Wavelength (nm)

(a)

|E| max = 7
Gap = 1 nm
|E| max = 169

(b)

|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
Scattering Spectroscopy of Nanoaggregates

(a)

(b)

(c)

(d)

(e)

(f)

(g)

(h)

J. Mod. Optics 2013, 60(14), 1107
Geometric Arrangements and Local Optical Field Variations

(a) 121.4

(b) 104.6 72.2

(c) 88.2 26.6

(d) 74.0 33.9

(e) 160.3 137.8

(f) 129.4 99.2 62.5 32.4

(g) 74.9 51.2 34.9

(h) 73.8

(i) 178.2 144.5

(j) 170.4 140.9 109.7 76.6 32.3

(k) 95.1 75.7 53.1 51.3

(l) 125.5 125.5 34.3
Influences of Aggregate Geometric on the Electric Field Distribution

Close-Packed

Scoop

Shovel

Spade

EF ~ 0.3 x $10^8$

EF ~ 3.9 x $10^8$

EF ~ 1.4 x $10^9$

EF ~ 3.0 x $10^9$

E-field @ Max

E-field @ Min

Trimer
Tetramer
Pentamer
Hexamer

E-field Strength (arb. units)

Wavelength (nm)
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

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