

Surface Plasmon Resonance

General Introduction

Steffen Jockusch 07/15/07

Plasmons:

- collective oscillations of the “free electron gas” density, often at optical frequencies.

Surface Plasmon Resonance

General Introduction

Steffen Jockusch 07/15/07

Plasmons:

- collective oscillations of the “free electron gas” density, often at optical frequencies.

Surface Plasmons:

- plasmons confined to surface (interface) and interact with light resulting in polaritons.
- propagating electron density waves occurring at the interface between metal and dielectric.

Surface Plasmon Resonance

General Introduction

Steffen Jockusch 07/15/07

Plasmons:

- collective oscillations of the “free electron gas” density, often at optical frequencies.

Surface Plasmons:

- plasmons confined to surface (interface) and interact with light resulting in polaritons.
- propagating electron density waves occurring at the interface between metal and dielectric.

Surface Plasmon Resonance:

- light (λ) in resonance with surface plasmon oscillation

Requirements:

- Material with free electrons:

Metals

Pb, In, Hg, Sn, Cd

Cu, **Ag**, **Au**

plasma frequency

UV

VIS

Requirements:

- Material with free electrons:

Metals

Pb, In, Hg, Sn, Cd

Cu, **Ag**, **Au**

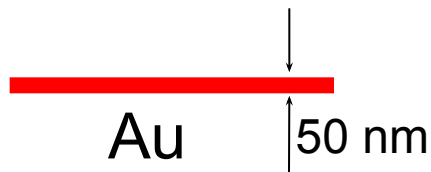
plasma frequency

UV

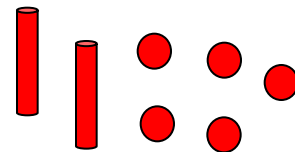
VIS

- Surface (interface):

flat surfaces



nanoparticles



Requirements:

- Material with free electrons:

Metals

Pb, In, Hg, Sn, Cd

Cu, **Ag**, **Au**

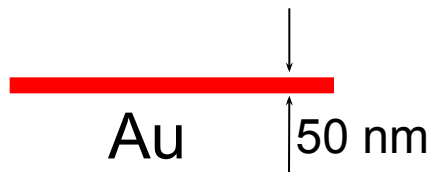
plasma frequency

UV

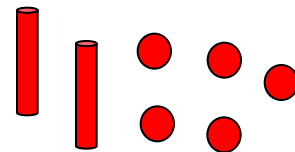
VIS

- Surface (interface):

flat surfaces

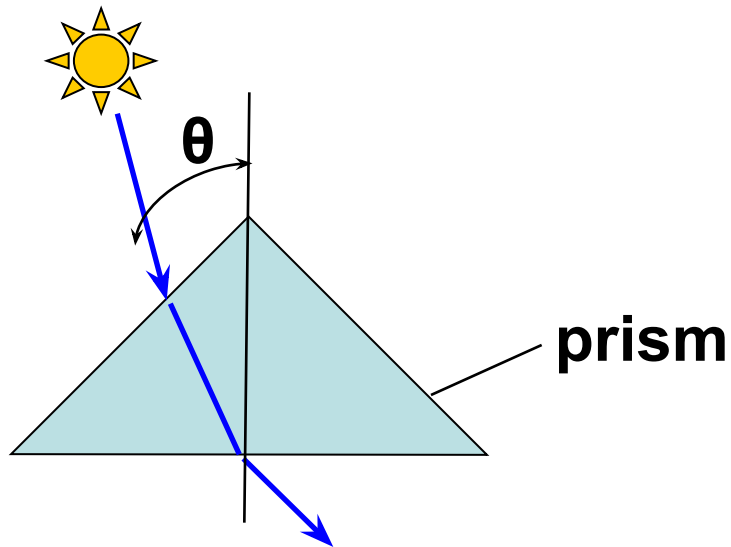
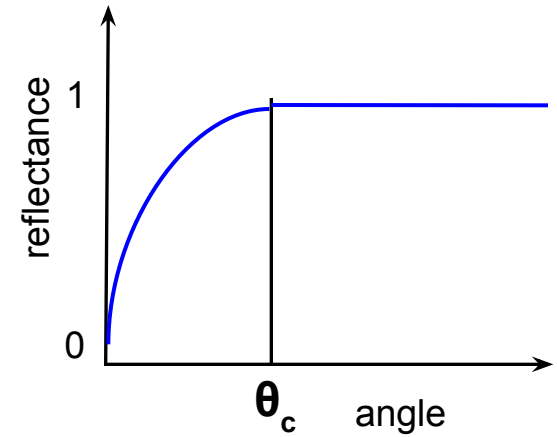
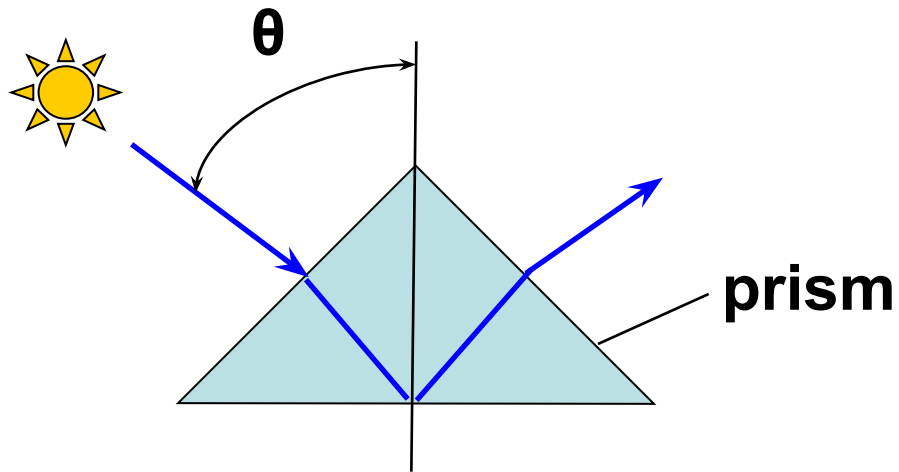


nanoparticles

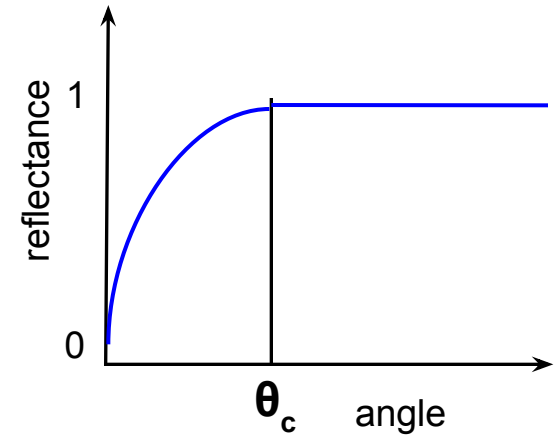
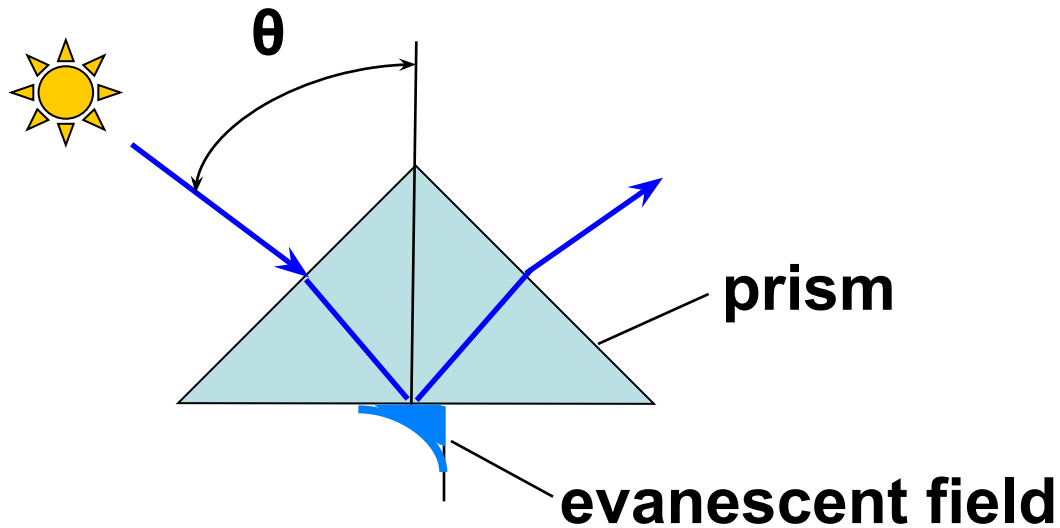


- **Light:** How to couple the photons to the surface?

Total reflection on a prism

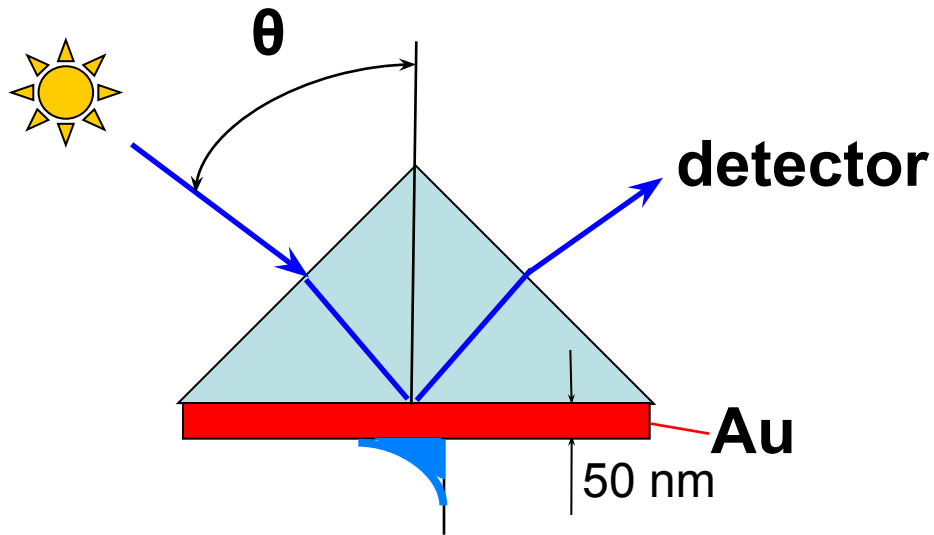


Evanescent Wave

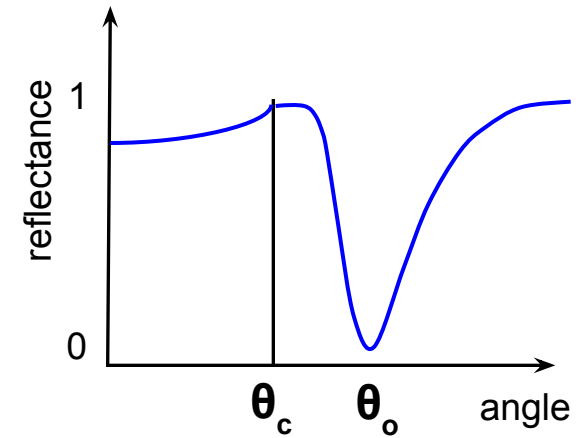


evanescent wave: - nearfield standing wave,
 - extends about $1/2 \lambda$,
 - decays exponentially with the distance

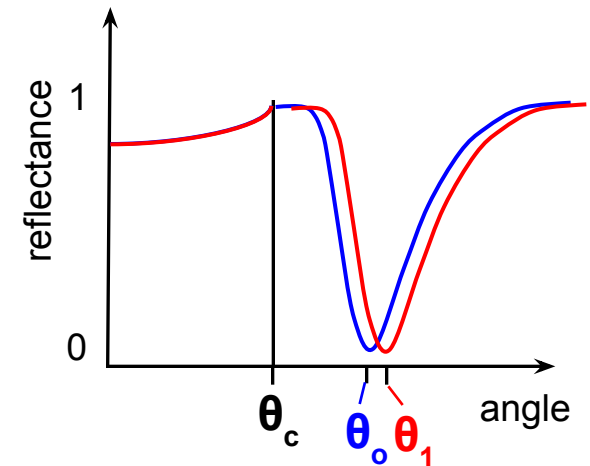
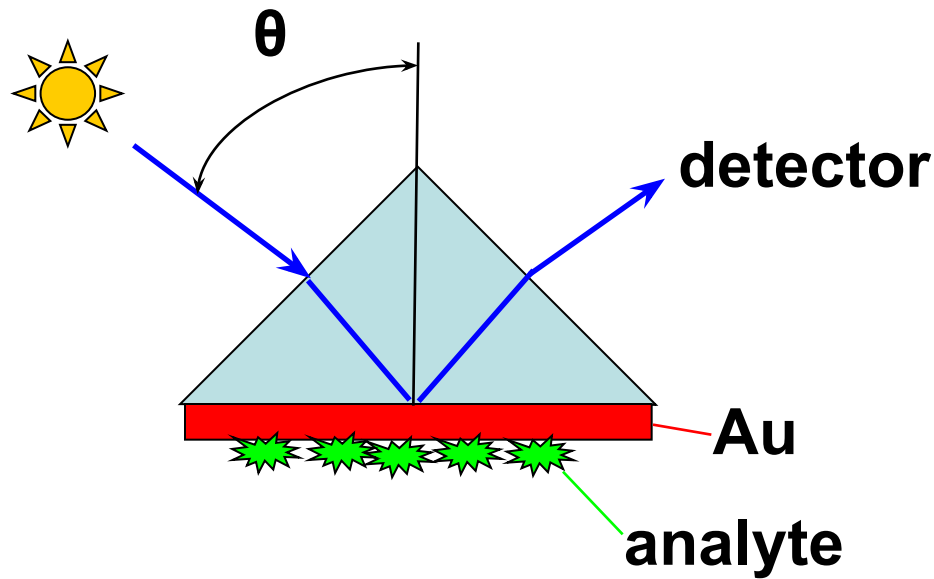
Surface Plasmon Resonance



(Kretschmann)



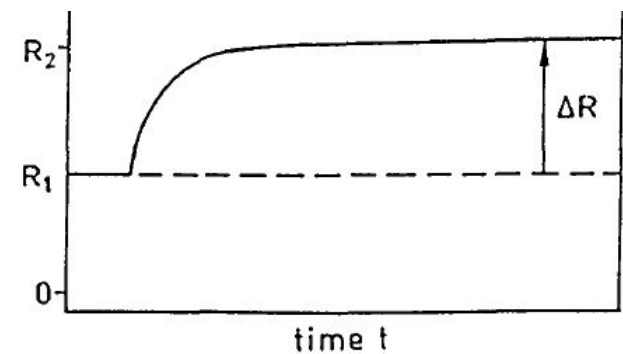
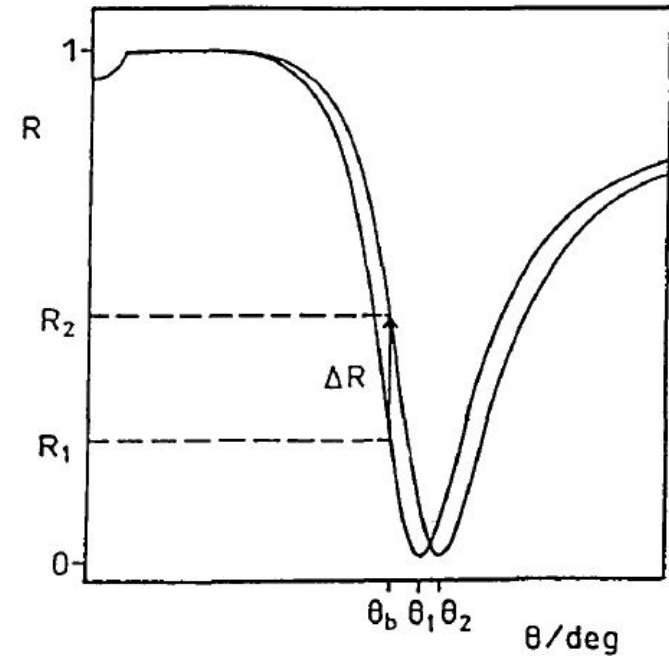
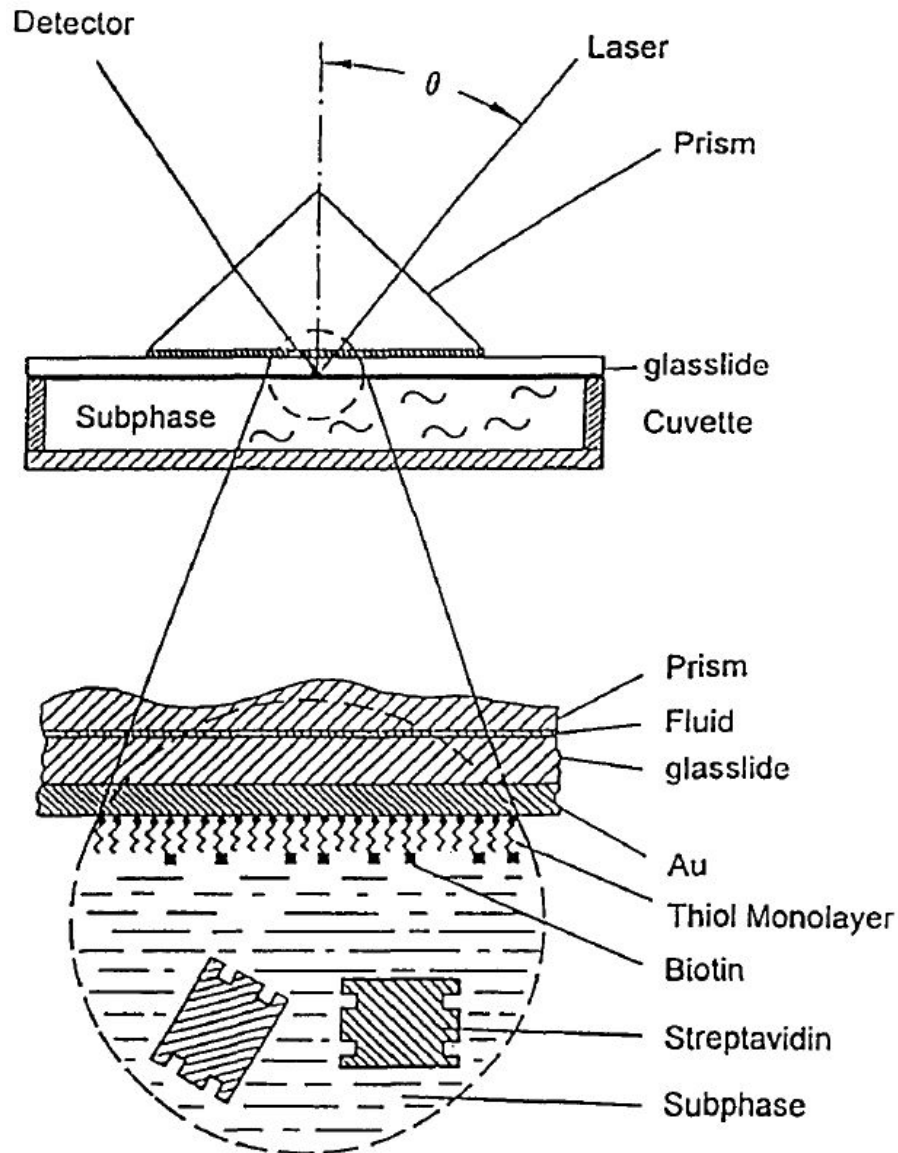
Surface Plasmon Resonance Spectroscopy



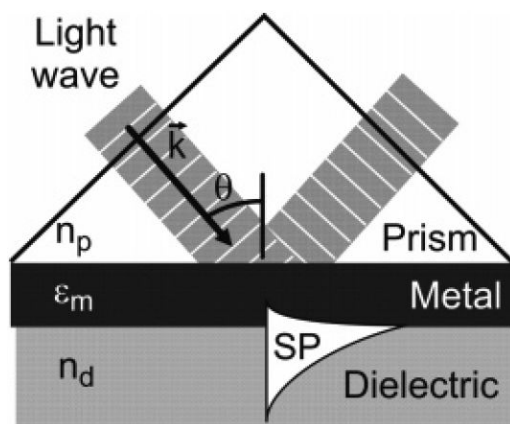
To measure:

- thickness changes,
- density fluctuation,
- molecular adsorption

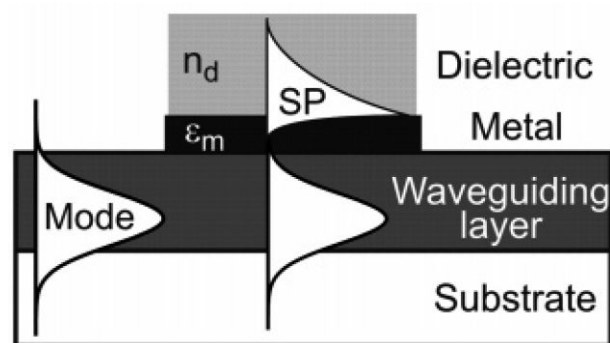
Surface Plasmon Resonance Spectroscopy in Sensors



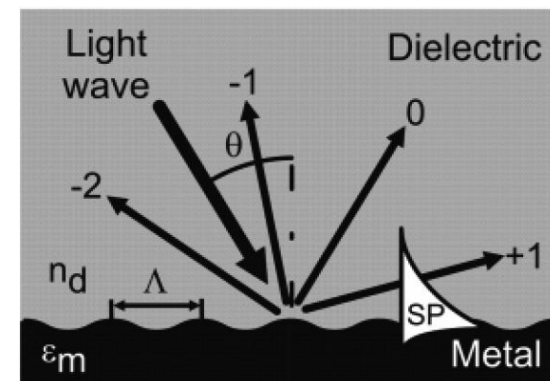
Coupling of Light to Surface Plasmon



**Prism coupler
(Kretschmann)**

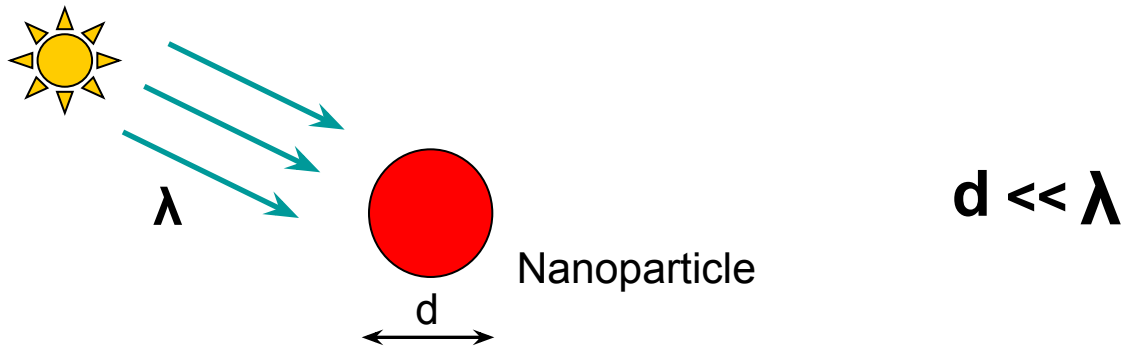


Waveguide coupler

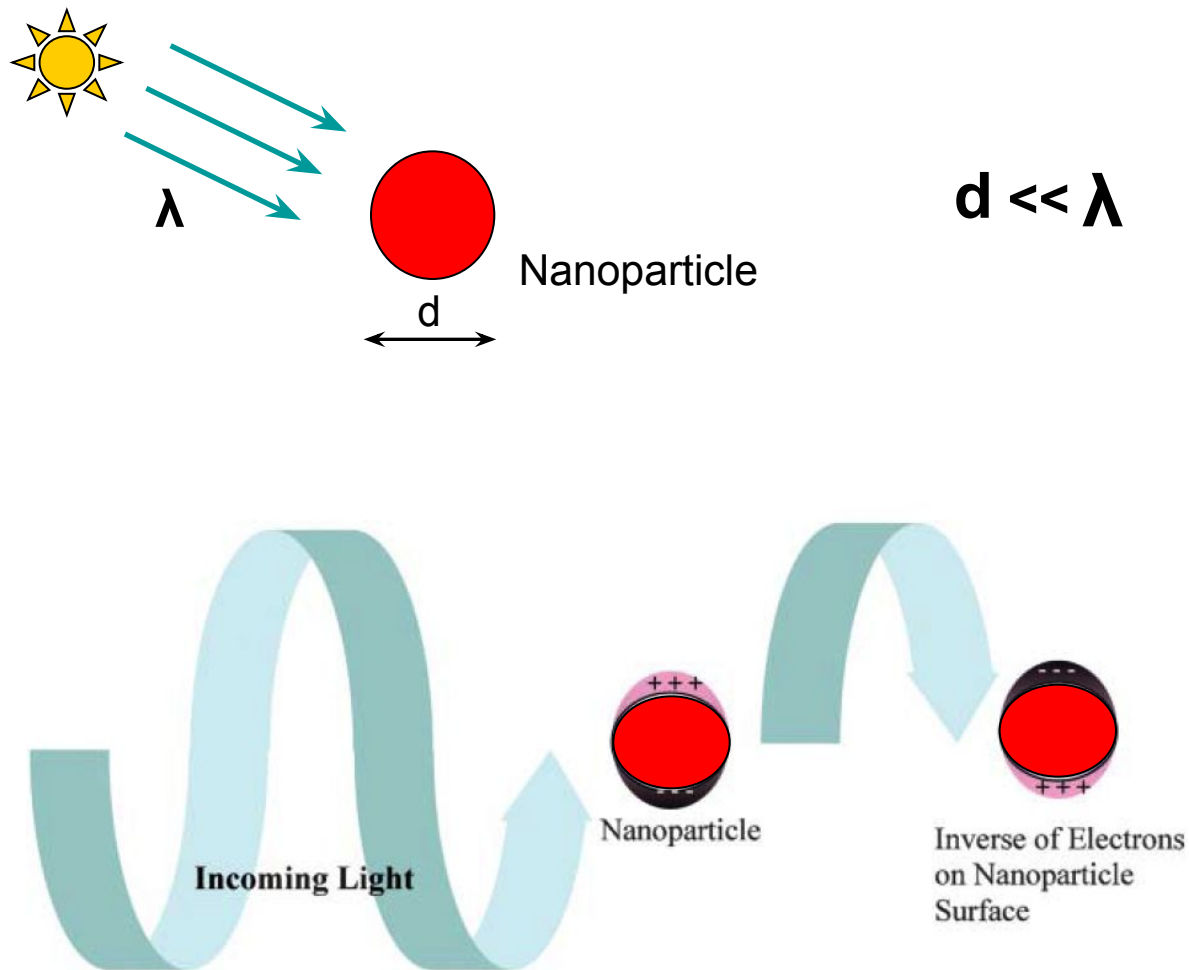


Grating coupler

Nanoparticle Surface Plasmon



Nanoparticle Surface Plasmon



Light resonance with the surface plasmon oscillation

causes the free electrons in the metal to

Surface Plasmon-assisted Spectroscopy

<i>Technique</i>	<i>Largest enhancement factor</i>
Surface enhanced raman SERS	10^{14} Nie and Emery, <i>Science</i> , 1997 , 275, 1102.
Surface enhanced IR SEIRA	10^4 Tsang, et.al., <i>Phys. Rev. Lett.</i> , 1980 , 45, 201.
Sum frequency generation SESFG	10^4 Baldelli, et.al., <i>J. Chem.Phys.</i> , 2000 , 113, 5432.
Second harmonic generation SESHG	10^4 Chen, et.al., <i>Phys. Rev. Lett.</i> , 1981 , 46, 145.
Surface enhanced fluorescence SEF	~ 100