IMPEDANCE METHODS FOR ANALYZING SURFACE PLASMONS

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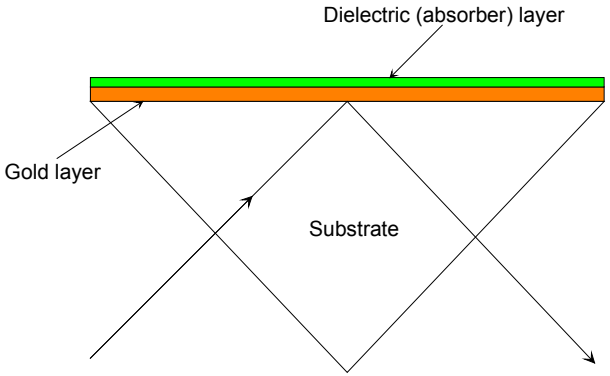
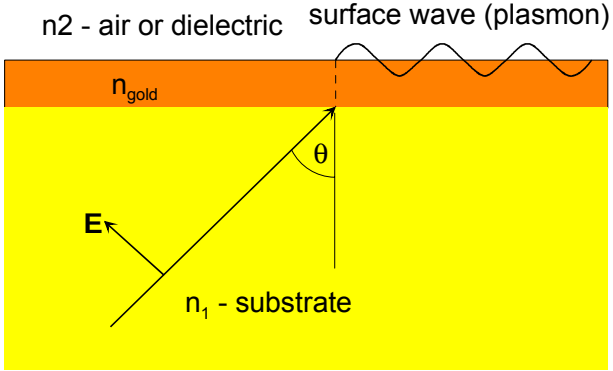
SURFACE PLASMONS

- Classical solutions to Maxwell's equations at the interface between a dielectric and a metal
- A metal is a dense electron-hole plasma
- A metal has a complex dielectric constant with a large negative part.
- For example, for gold at 632.8nm ε_2=-15.73-j0.968

Kretschman total internal reflection geometry for plasmon excitation





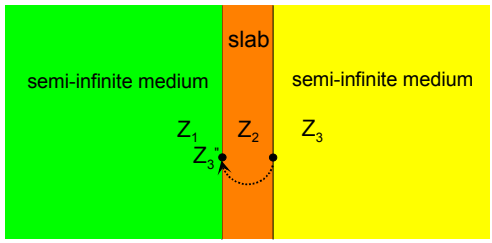
IMPEDANCE TRANSFORMATION

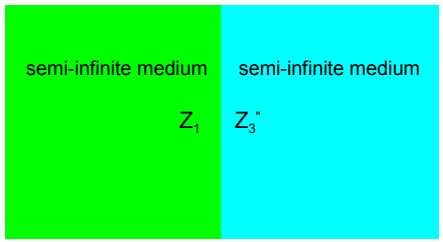
If a slab structure is modeled as a series of transmission lines then the impedance observed at the first interface, at location *z*= -*d* relative to a final interface at *z=0* is

$$Z_3^{''} = Z_2 \frac{[Z_3 \cos(kd) + jZ_2 \sin(kd)]}{Z_2 \cos(kd) + jZ_3 \sin(kd)}$$

This approach can be applied in slab structures to analyze electromagnetic wave reflection and transmission

Impedance transformation reduces the number of interfaces by one

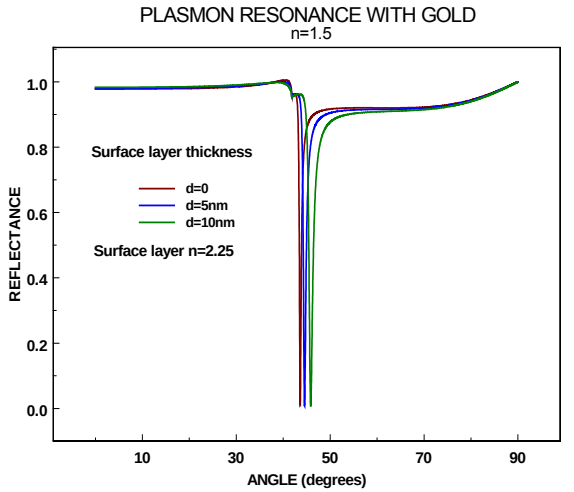




$$\rho = \frac{Z_3^{''} - Z_1^{'}}{Z_3^{''} + Z_1^{'}}$$

For P(TM) waves $Z^{'} = Z\cos(\theta)$

Plasmon resonances in gold revealed by an impedance analysis



The resonance angle is very sensitive to a surface layer on the gold