Gold Nanorods as Novel Nonbleaching Plasmon-Based Sensors for Molecular Orientations and Local Refractive Index Changes

Motivation

Observation of single molecule orientation

1. Lateral movement of beads ‘localization’

- 760nm bead

But: large bead

=> large perturbation


2. Fluorescence polarization of single dyes

- DNA connector dye capsid
- quartz slide antibody

But: bleaching & blinking

=> only short time useable

T. Hugel et al., unpublished

New Label: Gold Rods

- Produced by chemical synthesis

TEM picture

- Size: approximately 20x60 nm => less perturbation
- strong continuous signal
Plasmons

- At eigenfrequency of the collective e⁻ oscillation:
  strong light scattering

- Rods scatter light polarized along the long axis

Dark-field Microscope

- True color picture
- Every dot is one particle
- The color (≡ resonance wavelength) depends on aspect-ratio, size and shape of the particle
Rotation of Rods

- Polarization along the long axis => rotating particles ‘blink’ if a polarizer is used

Analysis of a Rotating Particle

- Intensity ~ \( \cos^2(\Theta) \)
- If \( \Theta \) is uniformly distributed

=> Measurement shows Brownian rotation
Splitting the Two Polarizations

Both polarizations

Bifringent crystal

Nano Lett. 5, 301 (2005)

Future Work

- Functionalization of rods
- Attachment of biomolecules
- Watch dynamics
Rods as Refractive Index Sensor

Refractive Index $n_1$

Refractive Index $n_2 > n_1$

$\Rightarrow$ Plasmon resonance wavelength shift

Influence of the Refractive Index

$y = 164.6x + 389.61$

$\Rightarrow$ Gold rods can be used as refractive index sensors
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