Common nanoparticles for quenching the fluorescence signal in biosensors

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Abstract

Introduction: Over the past ten years, nanoscience has gained eminence and the ever increasing growth has been contemplated in its advances in the field of drug delivery, nanomedicine, bioimaging, sensing, nanofabrication etc. Intensive research has stimulated for the development of highly selective and sensitive agents as a replacement of the formal sensing technologies. In this regard, metal nanoparticles such as silver, gold, copper etc. serve as the attractive probe candidates. Their chemically tunable optoelectronic properties, shapes and sizes, compositions make these materials ideal for detection of analytes.

Methods: Fluorescence-based assays and detection techniques are among the most highly sensitive and popular biological tests for researchers. Fluorescence activatable probes are made up of at least two components: the fluorophore that acts as the donor and the quencher that acts as the acceptor. FRET occurs through the dipole-dipole interactions between an excited donor (D) molecule and an acceptor (A). Fluorescence quenching-based "turn-on" assay is one of the most important applications among various energy transfer based techniques, in which the fluorescence of the donor can be effectively quenched by the acceptor in the absence of the targets.

Results and discussion: It is expected that the application of silver and gold nanoparticles based energy transfer will be increased, because the detection of metal ions and biomacromolecules need still be explored. The next developing photonic devices can be designed based on the energy transfer from fluorophores to the nanoparticles.

Conclusion: In this study we have made an attempts to emphasize on the importance of silver and gold nanoparticles induced super efficient fluorescence quenching of varied donor systems.

Keywords: Gold nanoparticle (GNP), Biosensor, Quench, Fluorescence, FRET, NSET

Why nanoparticles?!

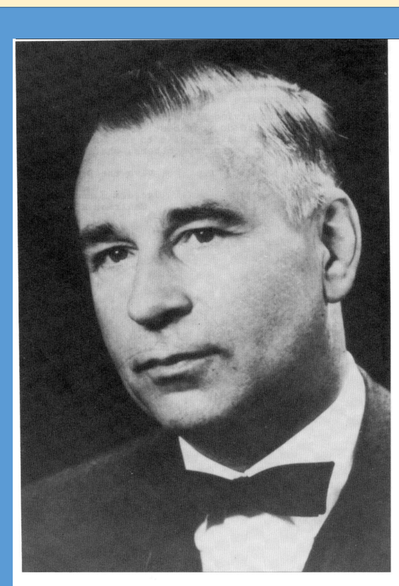
- **Nanoparticles** are particles between 1 and 100 nanometers in size.

- Scientific research on nanoparticles is intense as they have many potential applications in medicine, physics, optics, and electronics.
- Nanoparticles can exhibit size-related properties significantly different from those bulk materials.

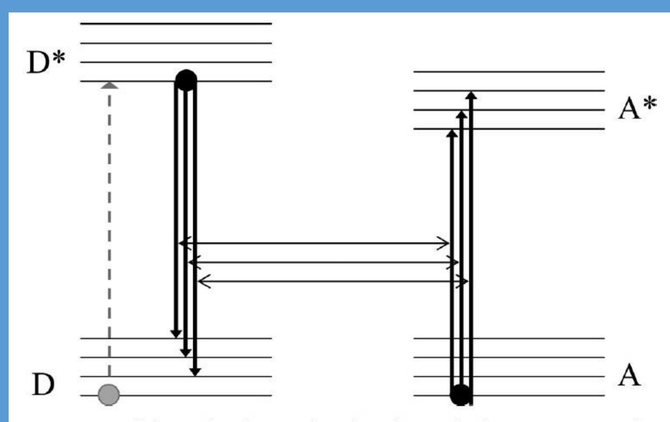
Lycurgus cup

Why quenching phenomenon happen?

- In 1946, Theodor Förster describe Förster resonance energy transfer (FRET).
- Quenching is the basis for Förster resonance energy transfer (FRET) assays.
- Quenching happens because of donor emission and quencher absorption spectral overlap.



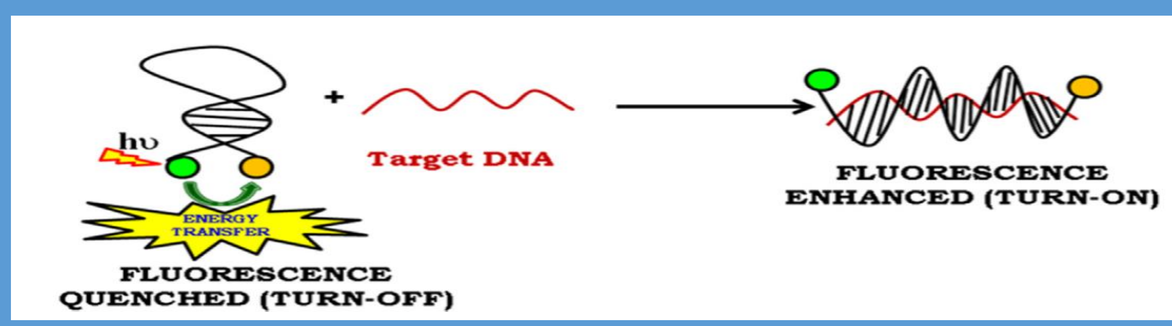
Theodor Förster
1910 - 1974



Schematic picture showing the excitation energy transfer between two spatially separated donor (D) and acceptor (A) molecules. The excited states of D and A are represented by D* and A*, respectively. The resonance energy transfer mediated via Coulombic interaction is represented by double sided arrows between D and A

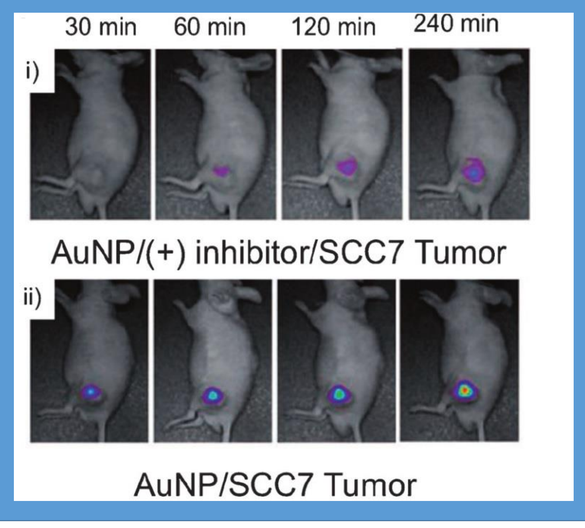
- Energy transmitted from excited state of fluorophore to ground state of quencher.

Applications in biosensors:



- For example, we can use gold nanoparticle as quencher and a dye as fluorophore to detect a specific DNA target.

- Near-infrared fluorescence (NIRF) images of tumor-bearing mice after injection of the AuNP probe (i) with and (ii) without an MMP (Matrix metalloproteinase) inhibitor.



Discussion

- Reports in the literature of theoretical and experimental work have shown that metallic gold surfaces and nanoparticles are ultra-efficient **fluorescence quenchers.**
- The short review highlights the recent advances on the gold and silver nanoparticles induced efficient quenching of fluorescence from various fluorophores looking at the irpromising use as optical rulers and chemo-/bio-**sensors.**
- Inorganic gold nanoparticles (AuNPs) show the highest quenching efficiency (up to 99%) and therefore the highest sensitivity in the development of **activatable probes.**

Reference

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