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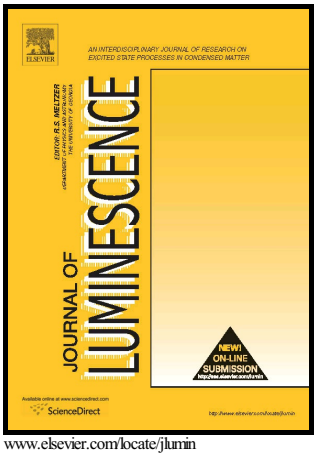

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Fluorescence Quenching and Energy Transfer in a System of Hybrid Laser Dye and Functionalized Gold Nanoparticles

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ABSTRACT

The photoinduced distance dependent molecular processes in a hybrid mixture of dyes and nanoparticles (NPs) were studied. Gold-NPs were functionalized with polyethylene glycol of different chain lengths in order to check their stability on storage in ethanol and to control the dye-NPs distance. The mixtures of NPs at concentrations from the range 10^{-9}–10^{-10} M with three laser dyes (C-481, C-510 and DCM), characterized by different yields of fluorescence and fluorescence emissions in different regions of the surface plasmon resonance spectrum of gold-NPs, were studied. It is shown that the energy transfer between the dyes and gold-NPs functionalized with polymer chains can be well described by the size-dependent NSET model. The most effective energy transfer was observed for the dye with the highest spectral donor-acceptor overlap integral despite the difference in donor fluorescence yield, it means that the overlap integral is the most important variable to predict the course and efficiency of this process in the hybrid dye-NP systems. The polymer layer was found not to interact with the dye but its thickness influenced the effectiveness of super-quenching of dye fluorescence (the Stern-Volmer constant, K_{SV}, 10^8 M^{-1}) caused by energy transfer. The hybrid mixture of laser dyes and pegylated gold-NPs seems to be very attractive for imaging and detection of targets in biological systems.

Keywords: fluorescence quenching efficiency, hybrid system, nanoparticles surface energy transfer, noble metal nanoparticles, surface plasmon resonance

1. Introduction

The continuous and dynamic development of nanotechnology allows the application of new, highly advanced materials in nanomedicine, nanobiology, bioimaging and optoelectronics [1]. Much interest has been focused on metal and semiconductor nanoparticles (NPs), which can act as attractive components of optical detection systems. Their tunable optoelectronic properties, shapes and sizes make these materials perfect for detection in nanoscale of analyte trace concentration [2–4]. Metal NPs have additionally been used in surface enhanced Raman