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The interfacial interactions of Tb-doped silica nanoparticles with surfactants and phospholipids revealed through the fluorescent response

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ABSTRACT

The quenching effect of dyes (phenol red and bromothymol blue) on Tb(III)-centered luminescen enables to sense the aggregation of cationic and anionic surfactants near the silica surface of Tb-dop silica nanoparticles (SN) in aqueous solutions. The Tb-centered luminescence of non-decorated SN diminished by the inner filter effect of both dyes. The decoration of the silica surface by cationic s factants induces the quenching through the energy transfer between silica coated Tb(III) complexes a dye anions inserted into surfactant aggregates. Thus the distribution of surfactants aggregates at silica/water interface and in the bulk of solution greatly affects dynamic quenching efficiency. The d placement of dye anions from the interfacial surfactant adlayer by anionic surfactants and phospholip is accompanied by the "off–on" switching of Tb(III)-centered luminescence.

1. Introduction

Fluorescent silica nanoparticles have gained a great attention during recent decades due to their bioanalytical application [1–4]. The correlation between luminescence of nanoparticles and the interfacial interactions is a top of current interest, since nanoparticles for biomarking should exhibit stable in time luminescence, which is not quenched at a binding with biotarget, while stimuli responsive luminescent nanoparticles are required for biosensing [5–13]. Lanthanide centered luminescence is of particular importance for bioanalytical and medical applications [14,15]. Thus lanthanide complexes both in the molecular form and silica coated are widely applied in bioanalysis [16–23]. The sensing of substrates is based on various mechanisms of quenching or enhancement of lanthanide centered luminescence. The energy transfer or so-called Förster mechanism is especially important for silica coated lanthanide based luminophores, since it is significant at rather long distances between luminescent and quenching molecules (1–7 nm) [24,25]. Thus the energy transfer from donors (Eu(III) chelates incorporated into nanoparticles) and proteins labeled with dyes has been successfully applied in the sensing of proteins or their aggregation [26]. The labeling of substrates by dyes is the p requisite step of the abovementioned route of the fluoresce recognition. The present report introduces novel approach sense nonlabeled substrates through the fluorescent respon of lanthanide doped silica nanoparticles (SNs) with the use dye molecules as a probe. The applicability of this approach exemplified in the interfacial interactions of SNs with cation as well as anionic surfactants and phospholipids. It is wo noting that the development of the procedure, which can sel tively probe the aggregation of surfactants at the silica/wa interface of nanoparticles is rather appealing task from the vie points of both fundamental and practical significance. In particu the silica surface decoration is a required step for bioanal ical application of nanoparticles [27,28], while the adsorpti and further aggregation of surfactants at the silica/water int face is rather convenient alternative to covalent anchori due to the lack of multistep purification procedures [29–3 The previously reported silica coated Tb(III) complexes w p-sulfonatothiacalix[4]arene (42 ± 5 nm) are used as nanopar cles with lanthanide centered luminescence [33]. Luminesce Tb(III) complexes with p-sulfonatothiacalix[4]arene were us as dopants to silica nanoparticles [34]. This type of lumin cent SNs can be attributed to the so-called "expanded core–she morphology, where luminophores are distributed both within core and a shell, though this distribution is not homogenec

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