DYE-COATED TITANATE NANOTUBES AS A LIGHT HARVESTING **SYSTEM**

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Keywords: titanates, TiO2, FRET, hierarchical nanostructures

Titanate nanotubes (TiNT) have attracted a great attention over the last decade due to their unusual physico-chemical properties and potential use in many applications [1, 2].

Because of a high specific surface area and anionic nature of the surface, these nanotubes are characterised by good affinity to the dye molecules in cationic form, which can easily be adsorbed on the surface of TiNT from aqueous solutions forming compact monolayer [3]. Figure 1a shows isotherms of adsorption of 4 different dyes (EBT = Eriochrome Black T, MB = Methylen Blue, Rd101 Rhodamine 101, C3 = 3,3' diethyloxacarbocyanine iodide) on the surface of titanate nanotubes. The dyes in cationic form (MB, Rd101, C3) are characterized by much higher adsorption capacity than the dyes in anionic from (EBT) indicating that electrostatic interaction dominates the adsorption.

Despite very strong interaction between negatively charged TiNT and positively charged dve. the coupling of wavefunctions between them strongly depends on the nature of the dye. For example, both Rd101 and C3 are characterized by similar value of adsorption constants and maximal uptakes corresponding to a saturated surface of nanotubes with dye forming a monolayer (see Figure 1a). However, adsorption of C3 on the surface of TiNT result in rapid quenching of its luminescence even at small concentration of added TiNT, whereas addition of much larger quantities of TiNT to the Rd101 does not result in any noticeable quenching of its luminescence (see Figure 1b).



а

b)

Figure 1. a) Isotherms of adsorption of various dyes on the surface of TiNT, b) photoluminescence quenching of C3 and Rd101 dyes by addition of colloidal suspension of TiNT in ethanol. (concentration of added TiNT for C3 is 5×10^{-5} mol dm⁻³, for Rd101 is in range from 0 to 1.2×10^{-3} mol dm⁻³.

In case of C3, the luminescence quenching is probably resulted from electron injection to the conduction band of TiNT, which can be beneficial for charge separation in dye sensitized solar cell electrodes (DSSCs). In combination with high adsorption capacity it would allow to decrease the thickness of the light absorbing layer and improve current collection efficiency. Recent development in synthesis of multiscale hierarchical structures of TiNT [4] can also improve transport efficiency in the liquid or solid electrolyte in DSSCs.

In contrast, adsorption of cationic Rhodamine type fluorophores on the surface of TiNT can be utilized in antenna type light harvesting systems [5]. Indeed, adsorption of Rd101 on TiNT does not result in the quenching of dye luminescence (see Figure 1b). The average distance between dye molecules on the nanotube surface of can be adjusted by varying the loading of the dye on the nanotubes. The radiative lifetime of Rhodamine was found to be decreasing with an increase of dye loading, which may be attributed to Förster resonance energy transfer (FRET) between the dye molecules [6].

Our early studies indicate that titanate nanotube decorated with organic fluorophores can be used as nanoscale light harvesting antennas, which can be utilized in dye sensitised solar cells or fluorescent solar collectors.

References

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