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Dispersing agents for electrophoretic deposition of TiO_2 and TiO_2–carbon nanotube composites

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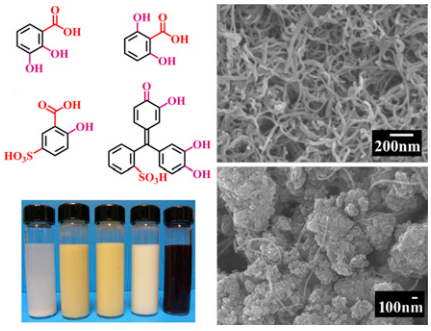
HIGHLIGHTS

- Molecules from catecholate and salicylate families allowed dispersion of TiO_2.
- The new anionic dispersant were used for electrophoretic deposition.
- Pyrocatecholsulfonphthalein allowed dispersion and deposition of carbon nanotubes.
- Pyrocatecholsulfonphthalein was used as universal dispersing agent.
- Composite TiO_2–carbon nanotube films were obtained by electrophoretic deposition.

GRAPHICAL ABSTRACT



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ABSTRACT

Organic anionic molecules such as 2,3-dihydroxybenzoic acid (DBA23), 2,6-dihydroxybenzoic acid (DBA26), 5-sulfosalicylic acid (SSA) and pyrocatecholsulfonphthalein (PCS) were investigated for electrophoretic deposition (EPD) of TiO_2 and TiO_2–multiwalled carbon nanotube (MWCNT) films from suspensions in ethanol. The adsorption of the molecules on TiO_2 surfaces was based on catecholate or salicylate binding, involving adjacent OH groups or adjacent OH and COOH groups, respectively. The adsorption of the anionic molecules allowed efficient dispersion, charging and EPD of TiO_2. The deposition yield was studied as a function of DBA23, DBA26, SSA and PCS concentration in TiO_2 suspensions and deposition time. An important finding was the possibility of efficient dispersion, charging and EPD of MWCNT using PCS. It was shown that PCS can be used as a universal dispersing agent for co-deposition of TiO_2 and MWCNT and fabrication of composite TiO_2–MWCNT films. The advantages of the new strategies, compared to other methods described in literature, were discussed. The deposits were studied by Fourier transform infrared spectroscopy, thermogravimetric analysis, differential thermal analysis and electron microscopy. The proposed approach paves the way for EPD of other oxide materials and composites.

1. Introduction

TiO_2 is an important material for electrochemical [1], photocatalytic [2,3], electronic [4,5], photovoltaic [6], biomedical [7,8] and cosmetic [9] applications. There is a growing interest in the development of TiO_2–carbon nanotube (CNT) nanocomposites with improved electronic conductivity for solar cells [10], gas sensors [11] and catalytic devices [12]. Many applications of TiO_2 and TiO_2–CNT composites are based on the use of thin films. The choice of a film deposition method is extremely important for the fabrication of advanced materials with controlled microstructure and properties.

Electrophoretic deposition (EPD) is an attractive technique for the fabrication of oxide and composite films [13,14]. EPD is achieved via electrophoretic motion of charged particles in a suspension toward an electrode and deposit formation under the

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