COLLOIDAL PHYSICAL CHEMISTRY TOWARDS ELECTROPHORETIC DEPOSITION (EPD)

Electrophoretic deposition (EPD) is known as an important tool for the production of wide range of coatings but which is extended to the nanoscale[1] in this work. The final target is here to control, through a bottom-up approach[2], the formation of nanostructured material associated with selective optical properties designed for photothermal solar collectors[3]. This study is focused first on stable charged colloidal dispersions, which are electrodeposited on substrate with tunable thickness, density and morphology. Carbon nanotubes (CNTs), deposited by electrophoretic deposition (EPD), are thus investigated as selective solar absorbers. First, various kinds of CNTs with different aspect ratios, are dispersed by ultrasound in an aqueous solution of pyrocatechol violet (PV). PV couples to the CNT's outer walls *via* π-π stacking interactions and acts as a dispersing agent as well as a charging agent. PV adsorption isotherms on CNT combined with N_2 physisorption isotherms are performed to optimize the CNT/PV ratio. In this way, Zeta potentials up to -40 mV are obtained for the dispersed CNTs, which are deposited on platinized silicon wafers by EPD, forming a film. The EPD kinetics are then investigated as a function of the applied electric field (in the 8-20 V cm^{-1} range) and are explained through a Sarkar & Nicholson model type (see fig. 1).

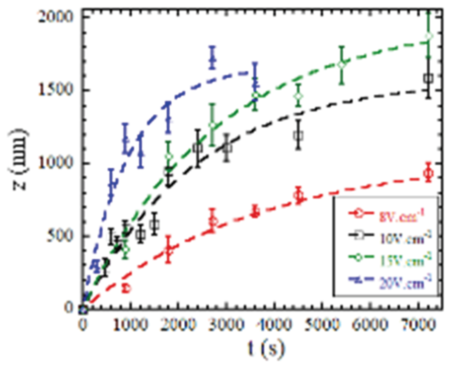

Figure 1. EPD kinetic of SWCNT coating

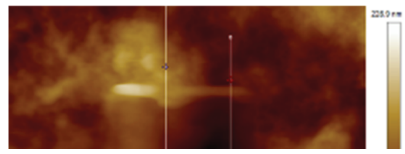

Figure 2. Nano-indentation constraint of 3 10^2 MP leading to 10% of the film compacting

X-ray reflectivity is performed to characterize the coating density around 1.3 g cm^{-3}, and film cohesion is probed by nanoindentation coupled to atomic force microscopy images (see fig. 2). The hemispherical reflectance of the samples is measured by spectrophotometers equipped with an integrating sphere, and following from spectra, the absorptance (a) and emittance (ε) are calculated[4]. The selectivity of the deposits, based on a and ε values, is then discussed as a function of the applied electric field and the coating thickness. Single-walled CNT deposits are found to have a solar absorptance of 0.91 and thermal emission of 0.05. Thermal annealing experiments reveal that the coatings could withstand up to 300 °C while sustaining selective properties and losing only 21% of the initial yield. The calculated efficiency of the tandem material would be also enhanced by adding an anti-reflective layer [5]. Advances in the understanding of deposition mechanisms are crucial to finally select the most promising coatings acting as an efficient solar absorber.

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