Ph.D. defense

Institut de Chimie Séparative de Marcoule / CEA Marcoule
(UMR 5257, CEA, CNRS, Université Montpellier, ENSCM)

FLORIAN DIDIER

will present his Ph.D. dissertation

Electrophoretic deposition of carbon nanotubes for the design of selective solar materials

The defense will take place on **Tuesday, December 13 2022** at **8.30 am**

at Ecole Nationale Supérieure de Chimie de Montpellier (Montpellier)

In order to promote the energy transition, different technologies for the exploitation of renewable energies are being studied, including photothermal panels. There are different types, including tandem solar absorbers. They are composed of a metal, highly reflective to IR radiation, covered by a material with a low reflectance in the UV-Vis-NIR range. In this thesis, the electrophoretic deposition process is used to produce selective solar surfaces. To design these surfaces, two single-walled and one multi-walled nanotubes are studied. The characterizations of the powders, by electronic microscopy and BET, showed that they have singular structures, rigid or wavy. These impact their specific surface, thermal resistance and solar radiation absorption properties. Nevertheless, nanotubes are able to absorb more than 90% of UV-Vis-NIR radiation. Subsequently, the nanotubes were dispersed by ultrasound and stabilized with an organic compound: purple pyrocatechol. This molecule adsorbs on the surface of the nanotubes by $\pi - \pi$ bonding and confers an electric charge to them, while ensuring an electrostatic repulsion. The stability and the zeta potential, of –35 mV, of the colloids were measured by dynamic light scattering and laser Doppler velocimetry. A parametric study allowed to determine the maximum adsorption capacity of this molecule by the nanotubes, as well as the optimal dispersion time of the nanotubes.

The nanotubes were deposited on a metallized silicon wafer and copper. By modifying the electric field (8 – 30 V.cm^{-1}) and the nanotubes/PV mass ratio, it is possible to rapidly produce submicron, adherent and homogeneous coatings. The growth kinetics of the coatings are in agreement with the model of Sarkar and Nicholson. X-ray reflectance determined that they have an average density of 1.3 g.cm^{-3}. The optical properties of the tandem solar absorbers showed, that depending on the thickness of the coatings, it is possible to absorb more than 90% of the UV-Visible-NIR light, while limiting the losses to 10% in the IR. Subsequently, tests have shown that the coatings maintain a mechanical resistance up to 350°C and can reach a theoretical efficiency of 40%.

Keywords: Carbon nanotubes; pyrocatechol violet; electrophoretic deposition; solar selective surfaces