# Ph.D. defense

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


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will present her Ph.D. dissertation

## Photothermal solar receptors obtained from the electrophoretic deposition of spectrally selective nanoparticles

The defense will take place on **Thursday, November 30, 2017** at **2.00 pm**

in Beyrouth University (Lebanon)


The production of hot water by using efficient photothermal solar collectors is growing in importance to limit the use of fossil fuels. Black copper (CuO) has proved to be one of the viable solar-selective coatings owing to its nearly intrinsic properties. The formation of a tandem absorber based on CuO thin film deposited onto a highly IR reflecting metallic substrate is processed by electrophoretic deposition (EPD).

In this way, the stabilization of a CuO colloidal suspension is studied previously by adding $Mg(NO_3)_2$ in isopropanol (IPA) or polyethyleneimine (PEI) in water suspension. Both acts as positively charging agents and allow the realization of a cathodic EPD. The colloidal stability as a function of the stabilizing agent content is studied prior to EPD, by dynamic light scattering (DLS) coupled with laser doppler velocimetry.

CuO tandem absorbers are obtained by varying different EPD parameters to control the final thickness and also the morphology. Consequently, the optical selectivity of the tandem material is tuned and optimized. The deposition yield is compared relative to the different applied voltage range, deposition time and nanoparticle concentrations. Homogeneous deposits are obtained for [CuO] = 5 x $10^{-4}$ g/cm$^3$ from both suspensions. The optimum applied voltage is found to be 50 V.cm$^{-1}$ for IPA suspension and 2 V.cm$^{-1}$ for $H_2O$ suspension, for deposition times of 30 mins and 120 mins, respectively. The composition and the thickness of the coatings are analysed by Grazing Incidence X-ray diffraction (GIXRD), scanning electron microscopy (SEM) and the density is obtained from energy-dispersive X-ray spectroscopy (EDX). For the previously mentioned optimized conditions, CuO tandem absorbers derived from IPA suspension possess a density of 1.69 g/cm$^3$ with high surface roughness. In contrast, homogeneous and regular surfaces are obtained from water suspensions having a higher density of 5.7 g/cm$^3$.

Moreover, absorptance (α) and emittance (ε) are calculated from the reflectance spectra of the UV-Vis-NIR and the Fourier transform InfraRed (FTIR) spectroscopy, respectively. α and ε were combined to determine the efficiency (η) of the tandem material. Tandems obtained from water suspension has η=0.8 -0.87 while from IPA η=0.7. Besides, the applicability of this EPD is checked by performing other deposit of CuO on metallic substrates of different types.

CuO tandems obtained from water suspensions are clearly more prominent to be used as solar selective tandem absorbers due to the high calculated η value reported. The efficiency of such selective tandem absorbers was further enhanced by carbonization (pyrolysis under inert atmosphere) of the polymer (PEI) embedded in the coating. Otherwise, a thin film of $SiO_2$ nanoparticles was deposited at the surface of the selective tandem absorbers to protect them.



Keywords: CuO; Electrophoretic deposition; Selectivity; Photothermal solar absorber