Photodegradation of linseed oil by CdZnS Nanocrystal Solid Solutions (NCSSs): effect of structure and composition

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It is well reported that CdZnS solid solutions represent a class of promising responsive photocatalyst due to their favourable band structures, and their tuneable photocatalytic efficiency. Properties like morphology, stoichiometry, and micro crystal structure can all influence their performance [1,2]. These compounds have been also employed as pigments in the art field since 1840s; unfortunately, the imperfection of earlier synthesis methods led to the commercialization of a variety of Cd/Zn sulphurs, whose heterogeneity in crystal structure and elemental ratio, i.e. the photocatalytic activity that they exercise over the organic binder in which they are dispersed, led to a rather fast paint degradation [3].

In this study, a series of $Cd_xZn_{1-x}S$ nanocrystals solid solutions (NCSSs) (x = 0, 0.2, 0.4, 0.5, 0.6, 0.8 and 1) has been synthesized and characterized with the aim of studying their photocatalytic activity under UV-Visible light, in relation to the degradation of linseed oil, a common organic binder used in paintings. Initially, the influence of temperature, time, and starting reagents were investigated by a Design of Experiment (DoE) model to optimize a synthesis method and obtain compounds with controlled characteristic such as stoichiometry, crystal phase (cubic, hexagonal, amorphous or mixtures), and particle size. Powders have been characterized by means of X-Ray Diffraction (XRD), Transmission Electron Microscopy (TEM) and UV-Vis Reflectance Spectroscopy. Oil-pigment thin films were then irradiated with a solar lamp for 8 weeks. The study of the effects of the various properties, especially structure, on the photocatalytic degradation of oil was carried out with a DoE model, using values extrapolated from Fourier-Transform Infrared Spectroscopy in Attenuated Total Reflectance (ATR-FTIR) spectra as a Response.

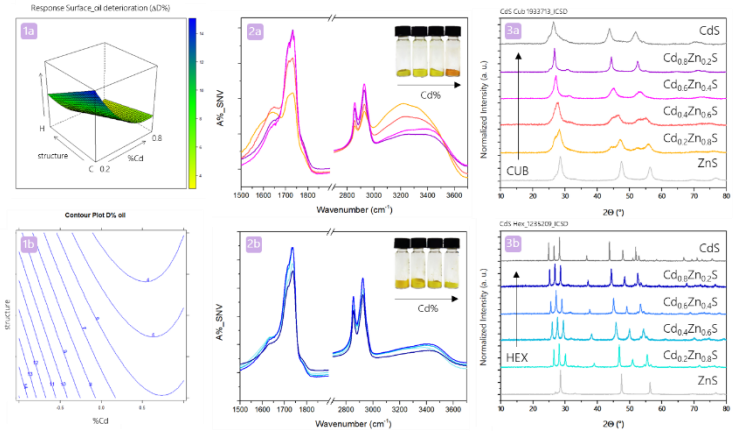

Figure. DoE (1a) Response Surface and (1b) isoresponse plot of linseed oil deterioration; ATR-FTIR spectra of oil-pigment thin films with (2a) cubic CdZnS NCSSs and (2b) hexagonal CdZnS NCSSs; XRD plots of (3a) cubic CdZnS NCSSs and (3b) hexagonal CdZnS NCSSs.

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