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Association of organic-inorganic filters and its potential as a hybrid sunscreen

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Abstract – In this work it is described the preparation of hybrid organic-inorganic filter as potential sunscreen filter. ZnO nanoparticles were associated with the organic filter Eusolex 9020® (Butyl-methoxydibenzoylmethane - bmdm) in several molar percentages. All samples were characterized by FT-IR, diffuse reflectance spectroscopy, and transmission electron microscopy. All hybrid filters present similar color indexes, absorption edge red-shifted in relation to ZnO matrix (BV → BC) and π → π* of bmdm absorption bands. The nature of the interaction between the organic filter and ZnO is related to the Zn-O bond in Zn^{2+} and bmdm coordination compound.

Oxide nanoparticles have been used in several areas: catalysts, electronic components, cosmetics, sunscreens, among others [1]. In sunscreens, oxide particles used as filters avoid the unwanted whitening effect caused by scattering of light when their particles size is below 400 nm. The aim of the present work is the preparation of an organic-inorganic association of the organic filter Eusolex 9020® (Butyl-methoxydibenzoylmethane - bmdm) with the inorganic oxide nanoparticles (ZnO) in order to apply the hybrid product in sunscreen formulations to minimize some of the problems related to the organic filter. The association of the filters was carried out with compounds suspension and/or solution in a mixture of ethanol and water. Powdered zinc oxide was suspended with an ultrasonic bath and the pH adjusted at 7, with ammonium hydroxide, which is a value bellow the ZnO isoelectric point range (9-11). The bmdm solution and/or suspension were added to the suspension of ZnO and the mixture was left under reflux at 50°C for 3 h. The volume of the solvents and the molar percentage of the filters for each sample are presented in Table 1. All samples were characterized by, diffuse reflectance spectroscopy, infrared vibrational spectroscopy (FT-IR), transmission electron microscopy (TEM) and energy dispersive X-ray (EDX). IR spectra of the samples exhibit the characteristic bands of bmdm and the Zn-O stretching band, but with different intensities ratio due to the different molar ratios of each compound used in the preparation conditions (Table 1). Kubelka-Munk approximation was used to obtain the absorption spectra from the diffuse reflectance data. Samples 1, 4 and 7 present the ZnO (BV → BC) absorption band and the bmdm π → π* absorption band. However, in all cases, the absorption edge is red-shifted, which is an evidence of the chemical association of the filters (Figure 1). The nature of the interaction between the organic and inorganic filters was related to the Zn^{2+} with bmdm bond in coordination compounds. Both compounds have analogue color indexes, and similar absorption spectra, from which it can be concluded that the interaction of Eusolex 9020® on the ZnO surface of particles are similar to the Zn-O bonds in the $[Zn(bmdm)_2]$ complex. From TEM, samples 4 and 7 show particles around 80 nm; besides there is evidence that the Eusolex 9020® filter is on the ZnO particles surface and this result is confirmed by EDX analysis. Finally, despite of the variation in the amount of the organic filter associated to ZnO as a result of each preparation, the nature of the interaction between the filters is similar, and the absorption edge red-shift in the hybrid filter enlarge the range of UV light absorption, leading to a potential material for the application in sunscreens.

Table 1: Molar percentage of the filter and volume of the solvents used in the preparation of the hybrid filter.

Sample	1	2	3	4	5	6	7
Water / mL	70	30	30	30	30	30	30
Ethanol / mL	100	140	140	140	140	140	140
Eusolex / mol-%	30	30	10	50	30	10	50
ZnO / mol-%	70	70	90	50			
ZnO[a] / mol-%					70	90	50

[a]Pretreated ZnO at 900°C for 3h.

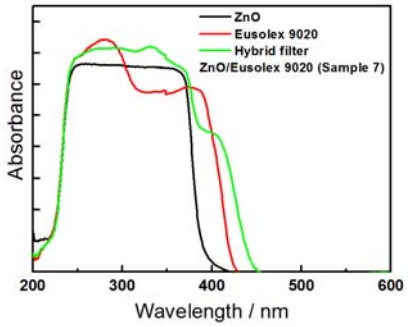

Figure 1: Absorption spectra of ZnO, Eusolex 9020® and a selected hybrid filter of ZnO/Eusolex 9020®

References

[1] Nohynek, G.J., Dufour E.K. and Roberts M.S. Skin Pharmacol Physiol **2008**;21:136–149.