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PHOTOCATALYTIC EFFECT OF $ZnO/Zn(OH)_2$ COMPOSITES ON ORGANIC DIRT FROM URBAN AIR

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- paper in short presentation -

Ultraviolet light and pollutants in dirty air became probably the most serious environmental risk of urban population by now. These affect topically for the most part, and their demagas may be prevented by applying invisible protective layer of durable UV absorbers having ability to deplete organic pollutants. Photocatalytic decomposition of organic impurities using semiconductors (e.g. CdS, TiO_2, ZnO) is well-known.

Semiconductor oxids are able to absorb UV radiations A, B and C in the range of wavelength 320-400, 290-320 and <290 nm, respectively, for long time. Among these oxides ZnO has some additional adventages such as good adsorption and acid taking, especially in topical applications. It would be worth preparing new composite materials, which combine a long UV protection with good adsorption properties and photocatalytic effect. on organic pollutants.

The aim of this work was to prepare $ZnO/Zn(OH)_2$ particles supported on UV permeable, film forming material, and to compare their UV protective and photocatalytic effects.

A synthetic layer silicate (Optigel - Synthetic hectorite, Süd-chemie) was chosen as active supporting material because of its good film forming and adsorption properties, and ideal light transparancy. Composites were prepared by surface precipitation of $Zn(OH)_2$ on hectorite lamellae and heterocoagulation of ZnO (NANOX 200 - 97.5% ZnO, 60 nm, Elementis) and hectorite particles. Hydrolysis of zinc salts, as well as the pH-dependent surface charging and also the dissolution of ZnO and hectorite particles were investigated by potentiometric acid-base titration.

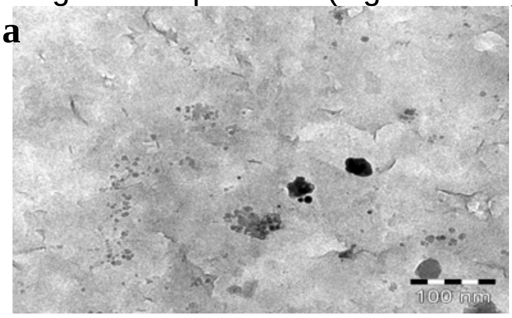
The stepwise hydrolysis of zinc salt starts at pH~6.5 and ~8, then takes place quantitatively up to pH~10, above which the alkaline dissolution of $Zn(OH)_2$ begins. Acidic and alkaline dissolution of ZnO takes place below pH~7.8 and above pH~11.4, respectively, while a typical amphoteric surface charging with point of zero charge (PZC) at pH~9.2 appears over the dissolution free range of pH.

Optigel contains alkaline impurities raising the pH of suspensions up to pH ~9,5. An acidic dissolution of Optigel crystal lattice starts at pH~7.2, but above this negatively charged lamellae are present in suspensions showing reversible reaction with H^+/OH^- in the range of pH ~7,3-11. On the basis of these results we could remove the alkaline impurities from supporting material, and adjust the optimal conditions for preparations of composites.

The different composites were characterized by X-ray diffraction, UV-VIS spectroscopy, transmission electron microscopy (TEM), specific surface area determination and rheology. The photocatalytic effect of thin films were tested with depletion of cigarette smoke using Quarz Crystalline Microbalance (QCM), and that of freeze-dried samples with ß-naftol decomposition exposed to UV radiation by measuring the Total Organic Carbon (TOC) content of solids in time.

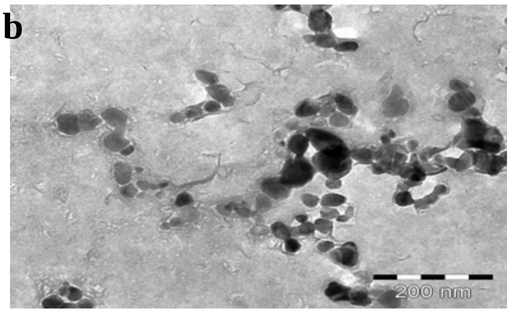
The following TEM pictures represent obviously the difference in the particle size of ZnO-Zn(OH)$_2$ formed in situ precipitation on the surface of clay lamellae (left-hand) and of ZnO attached to the clay particles in a heterocogulation process (right-hand).

a



ZnO-Zn(OH)$_2$/Optigel composites
Average particle size: 4.66±1.48 nm

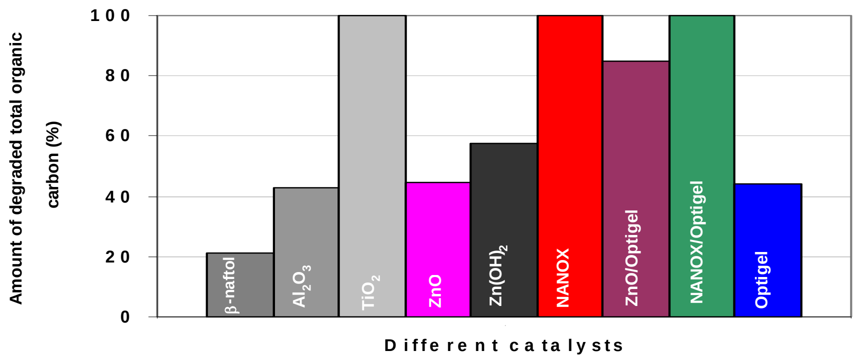
b



NANOX 200/Optigel composites
Average particle size: 43.37±16.25 nm

The ZnO-Zn(OH)$_2$/Optigel composites showed sharp increase in UV absorption only below 220 nm, from this absorption edge the estimated particle size of semiconductor ZnO is 2.2 nm. However, each sample containing NANOX ZnO particles showed an enhanced UV absorption below 390 nm, therefore composites containing Zn(OH)$_2$ can protect against only the UVC (<290 nm), while those with ZnO proved to be good protectives even in the UVA (320-400 nm) region.

The photocatalytic tests proved that both the depletion of cigarette smoke in natural light and the ß-naftol decomposition under UV radiation take place completely, and so ZnO/Zn(OH)$_2$ containing composites are able to mineralize organic pollutants adsorbing from dirty air.



Comparison of the photocatalytic efficiency of the different catalysts in ß-naftol decomposition

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