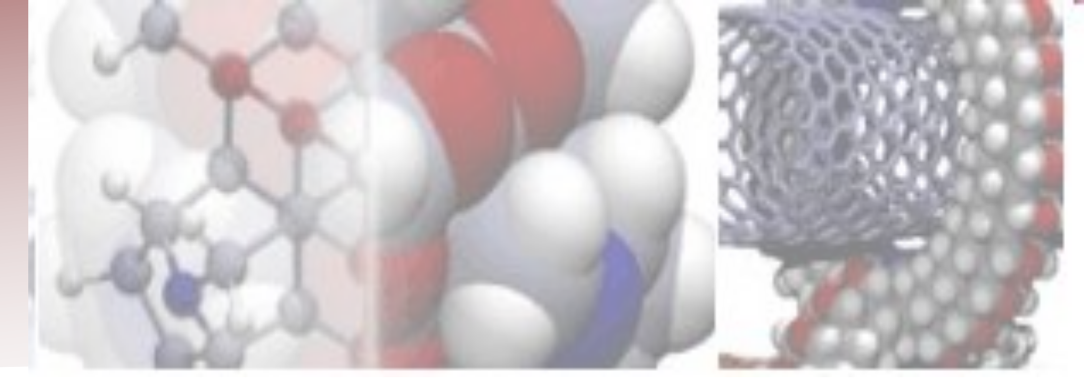

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Photocatalytic degradation of Eosin Y dye using SnO_2 nanocomposites

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The tin oxide based nanocomposites have been used as efficient and environmentally benign catalysts. The developed protocols using this kind of material are advantageous in terms of simple experimentation, reusable catalyst, excellent yields of the products, short reaction time and preclusion of toxic solvents. In this work, we have reported novel synthesis and characterization of supported SnO_2 catalysts.

INTRODUCTION

The elimination of toxic chemicals from wastewaters is presently one of the most important subjects in pollution control. An alternative to conventional water treatment processes is the advanced oxidation processes using solar radiation. [1-4]. Advanced oxidation processes involve the generation of hydroxyl (•OH) radicals which oxidize the pollutants. After fluorine, the hydroxyl radical is the second strongest known oxidant having an oxidation potential of 2.8 eV. It is able to oxidize and mineralize almost every organic molecule, yielding CO_2 and inorganic ions as shown in the following equations:

$$\bullet OH + RH \rightarrow R\bullet + H_2O$$

$$R\bullet + O_2 \rightarrow RO_2\bullet \rightarrow \text{Products and } CO_2$$

It is known that tin dioxide is a versatile material, applicable in many physical-chemical processes, being one of the most intensively studied semiconductors. SnO_2 is an n-type semiconductor with a direct band gap of 3.6 eV between the full oxygen 2p valence band and the tin states at the bottom of the conduction band.

EXPERIMENTAL

Preparation of SnO_2 nanometer powders

Bentonite montmorillonitic-clay, provided by firma Riedel-de Haen Chemicals Company, was used as starting material. The nanosize SnO_2 particles were prepared by two methods:

- Impregnation method;
- Pillaring method (dispersing the tin oxide particles) .

The novel materials was successfully synthesized in ethanol/water solution. By changing the reaction conditions, the size and the morphology can be controlled. In summary, we find an economical and efficient process for synthesizing SnO_2 nanocomposites. The concentration of NaOH and the ratio of water and ethanol are important to synthesize various morphologies of SnO_2 crystals.

These samples were investigated the photocatalytic oxidative degradation and discoloration of synthetic wastewater containing Eosin Y dye, varying the concentration of catalyst (0,5-2g/l).

Studies of photocatalysis

By changing the reaction conditions, the size and the morphology can be controlled. In summary, we find an economical and efficient process for synthesizing SnO_2 montmorillonite nanocomposites. The concentration of NaOH and the ratio of water and ethanol are important to synthesize various morphologies of SnO_2 crystals. These samples were investigated the photocatalytic oxidative degradation and discoloration of synthetic wastewater containing Eosin Y dye, varying the concentration of catalyst (0,5-2g/l).

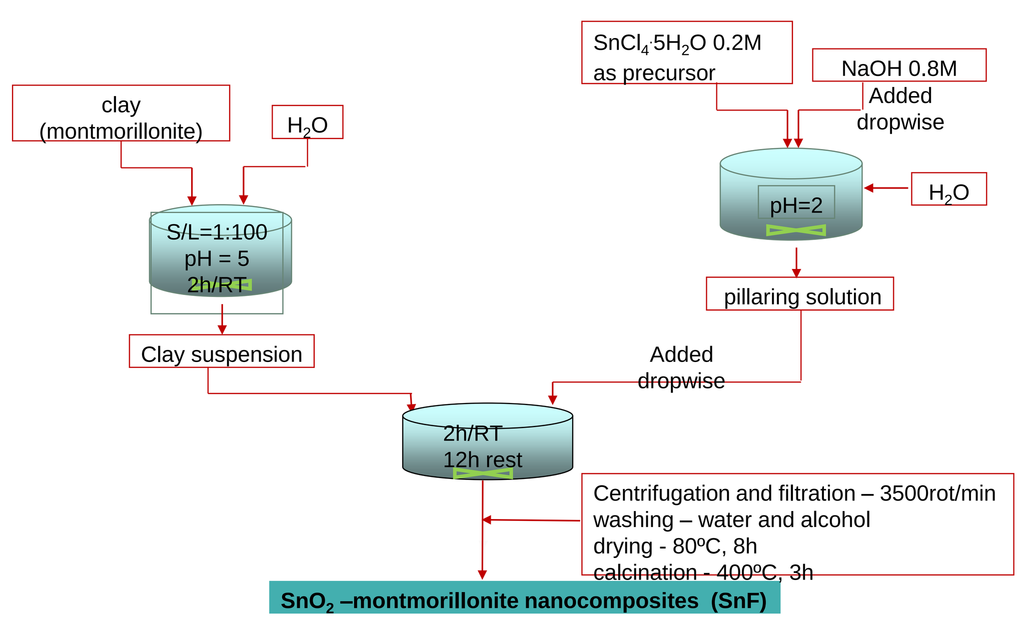

Figure 1:Preparation of SnO_2 nanometer powders by pillaring method

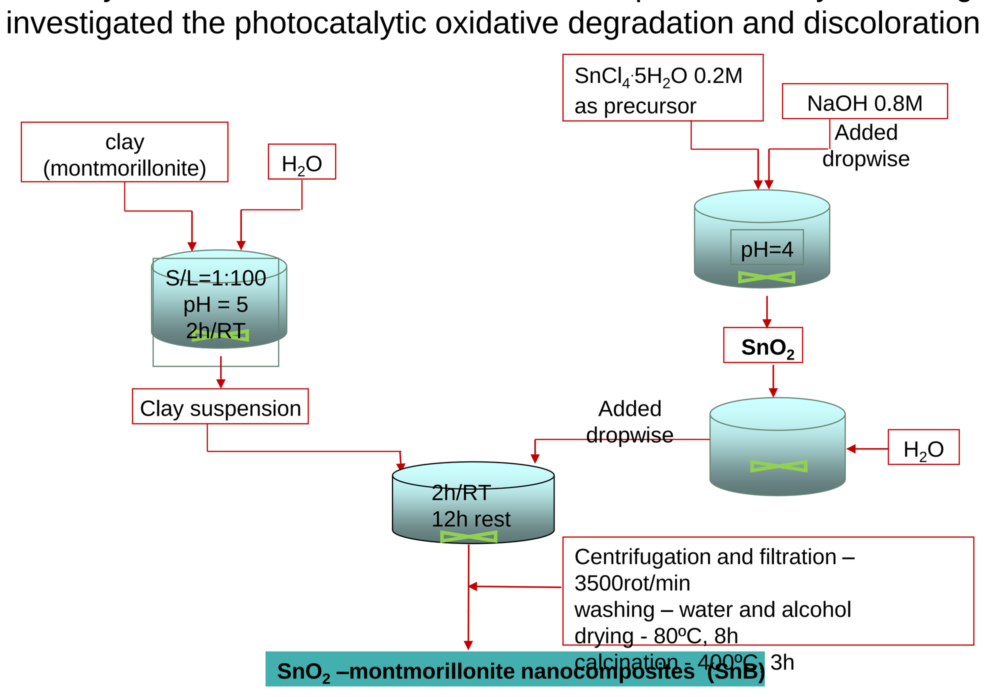

Figure 2: Preparation of SnO_2 nanometer powders by impregnation method

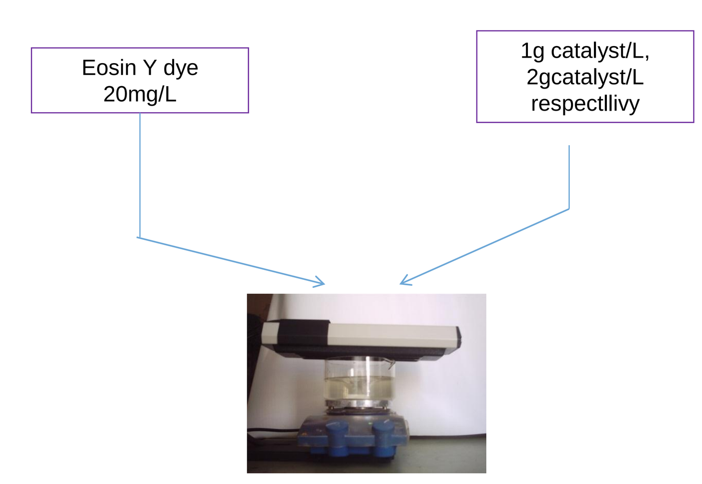

Figure 3: Studies of photocatalysis

Photocatalysis occurs in two stages:
- adsorption in the dark for 30 minutes;
- measured dye concentration, which is exposed to UV light wavelength of 254 nm at equal time intervals based on the calibration curve.

Characterization methods

The structure and properties of the obtained materials were studied by X-ray diffraction (XRD), FTIR spectroscopy, N_2 adsorption-desorption isothermsand UV–Vis difuse reflectance spectroscopy. The structures of pure and tin-oxide pillared clay were investigated using Shimadzu LabX XRD 6000 diffractometer. The diffraction angle was scanned form 10 to 80 degrees, a usual interval for complex clays and SnO2 . Measurement Condition was: X-ray tube, Cu target Cu, voltage = 40.0 (kV), current 30.0 (mA) and scanning: scan mode-Continuous Scan, scan speed 2.0000 (deg/min). FTIR spectra were recorded on a FTIR JASCO 660+ spectrometer. UV–vis diffuse reflectance spectra were studied by Shimadzu UV-2401 PC Recording Spectrophotometer of samples were obtained in the range 200–600 nm. The adsorption isotherms of N_2 , specific surface areas and porosities were determined with a Nova 2200e (Quantachrome Instruments) automated sorptometer at 77 K.

RESULT AND DISSCUSIONS

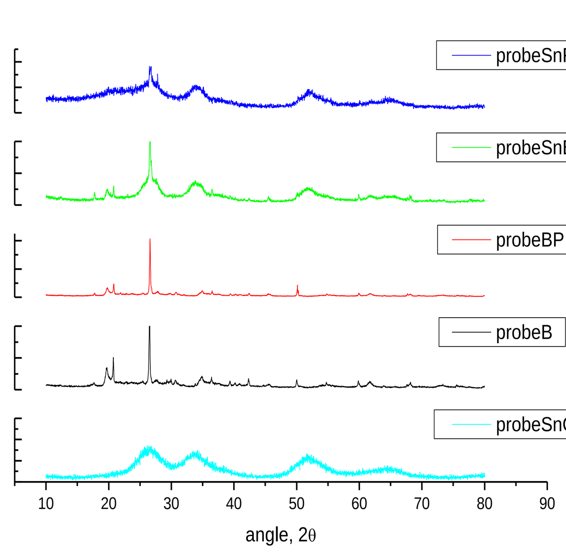

Figure 4; Comparative study between samples X-ray diffraction (XRD) patterns of the studied samples

Identification of peaks was performed using the diffractometer software. The pure clay presents all specific peaks for complex clays: quartz, bentonite, feldspar, aluminum silicate and mica. Reference diffractogram for thin oxide show a nanocrystalline powder with tetragonal structure of elementary cell, having lattice parameters: a=4.7200 Å, b=4.7200 Å, c=3.1700 Å.For this elementary cell dimensions, is well fitted in SiO2 sites of clay, as identification image show.

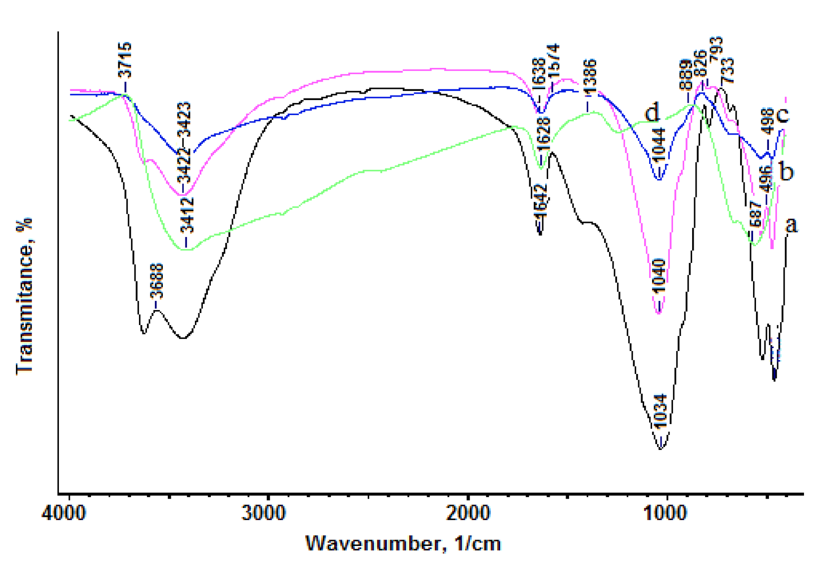

Figure 5: FTIR Spectra: a – clay; b - SnO_2 – clay nanocomposites (SnB); c - SnO_2 – pillared clay nanocomposites (SnF); d- SnO_2 nanoparticles

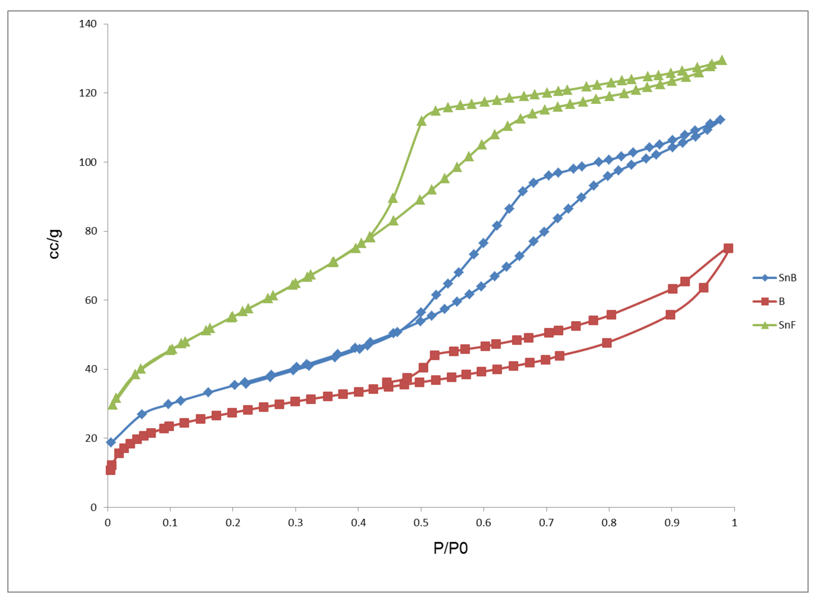

Figure 6: Nitrogen adsorption isotherm at 77k, for studied sample

Sample	Surface aria area, α^s_{BET} (m2/g)	Pore volume, cc/g	Pore diameter, nm
clay (B)	132.7	0.135	1.038
SnO_2 – clay nanocomposites (SnB)	234.2	0.203	1.155
SnO_2 – pillared clay nanocomposites (SnF)	191.4	0.165	3.851

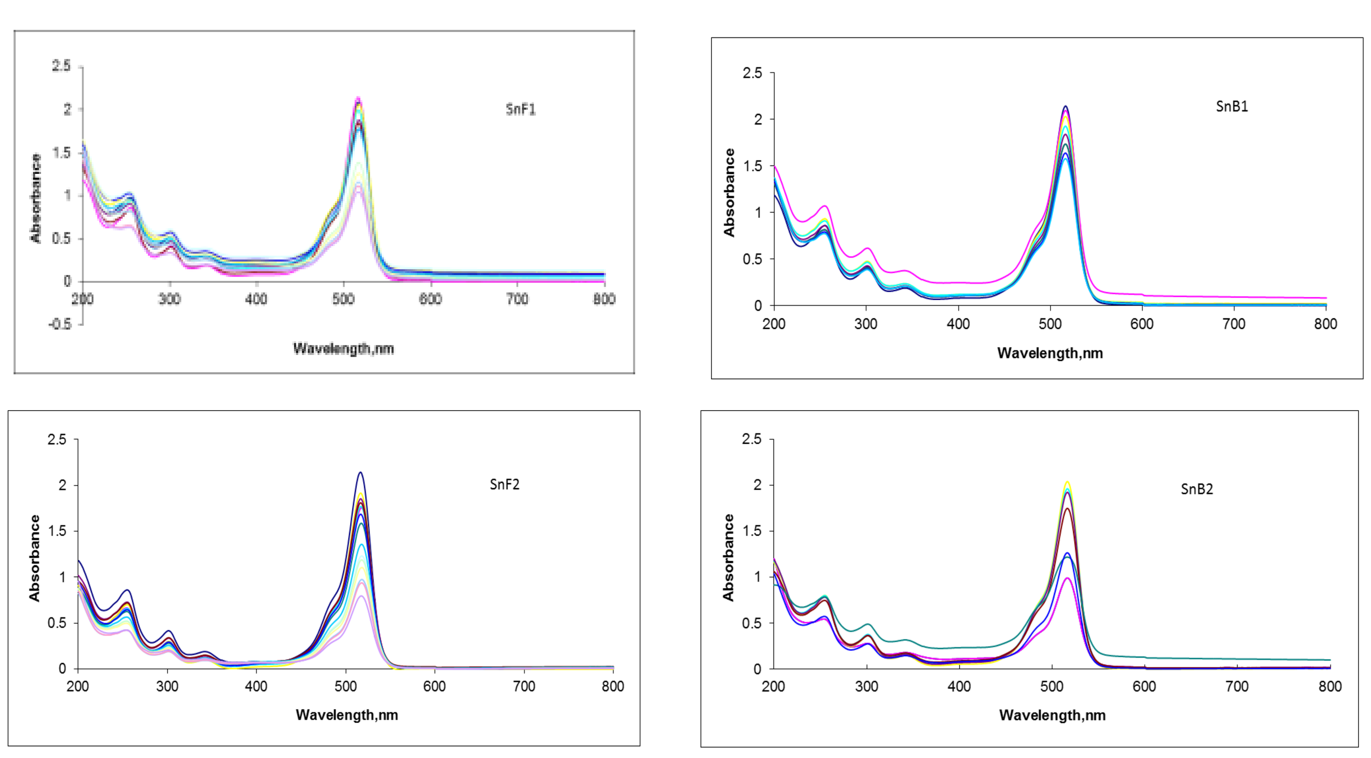

Figure 7; UV-vis spectra of the studied samples

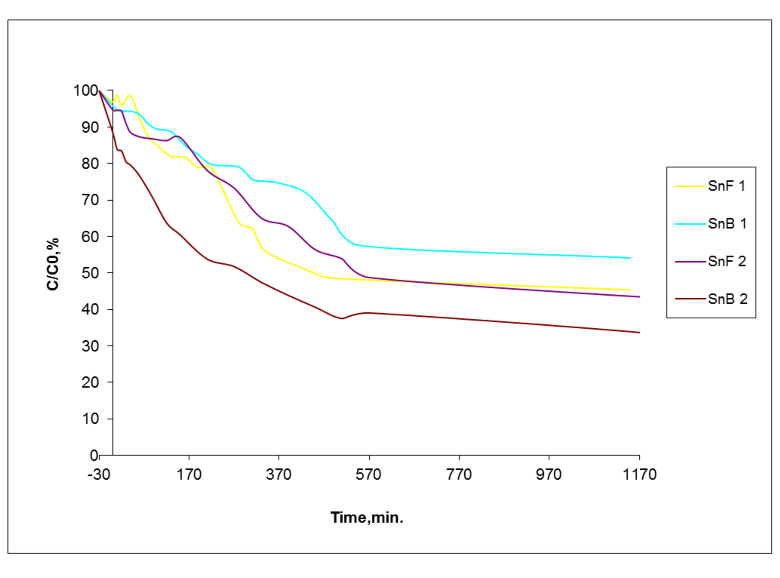

Figure 8: Relative residual concentration of Eosin Y dye (C/C0) after treatment with an aqueous solution of SnO_2 clay nanocomposites samples

Results obtained by spectrophotometric method show a decrease (60-70%) in dye concentration over time.

Degradation of Eosin Y dye (EY) – 20mg/L

electrical double layer of the solid-liquid interface

adsorption/desorption processes

separation of the e^-/h^+ pairs

❖ EY ⇔ xanthene fluorescent dye

CONCLUSIONS

- ❖ We reported the synthesis and characterization of some new nanocomposites obtained by Impregnation method and pillaring method (dispersing the tin oxide particles) - SnO_2 clay nanocomposites.
- ❖The physico-chemical properties of the studied nanocomposites were characterized by X-ray diffraction (XRD), N2 adsorption-desorption isotherms, FTIR spectroscopy and UV-Vis diffuse reflectance spectroscopy
- ❖The ability of the nanocomposites to degrade Eosin Y dye under UV light.
- ❖In this work, the photocatalytic oxidative degradation of Eosin Y dye, xanthene fluorescent dye, has been studied under solar radiation. It is observed that nanosized compound SnO_2/clay photocatalysts are efficient photocatalysts, both in respect of decolorization as well as mineral-ization.
- ❖Nanosized compound SnO_2/clay photocatalysts synthesized are for use in treatment of organic wastewaters by converting the carcinogenic compounds to harmless compounds.
- ❖Nanoporous materials have been a core focus in nanosciences, which is an ever-growing multidisciplinary field of study attracting tremendous interest, investments and effort in research development around the world

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