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Upotreba sondi cink dioksida za praćenje biološke i hemijske kontaminacije vode u civilne i vojne svrhe

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Apstrakt: Glavni organski zagađivači, i njihova nasumična široka primena ugrožava ljudsko zdravlje i ekosisteme. Jasno je da detoksikacija toksičnih insekticida iz vodenog sistema ostaje globalni prioritet. U ovoj studiji sintetisan je nanokatalizator cink oksida sa odgovarajućim svojstvima da bi se postigla potpuna degradacija nekih insekticida iz vodenih medija. ZnO katalizator je korišćen u normalnoj i nano veličini kao deo naprednog procesa oksidacije u prisustvu H2O2 i UV zraka. Potpuna detoksikacija testiranih pesticida nakon tretmana najefikasnijim procesom (ZnO(s)/H2O2/UV) je zatim ispitana istraživanjem biohemijskim tretmanom. Takođe je istražen uticaj tretmana vode ZnO. Zanimljivo je da je ova studija izvestila da su stope degradacije istraživanih insekticida bile brže korišćenjem ZnO katalizatora nano veličine nego običnog ZnO katalizatora kao i sondi cink dioksida. U tom smislu, potpuna razgradnja ispitivanih insekticida (100%) u sistemu ZnO(s)/H2O2/UV postignuta je nakon 320 min ozračivanja. Tretman vode nanokatalizatorom cink oksida poboljšao je kvalitet parametara vode. Zajedno, napredni procesi oksidacije koji koriste ZnO nanokatalizator mogu se smatrati obećavajućom tehnologijom tretmana za potpunu detoksikaciju metomila i dimetoata u vodi. Međutim, dalja istraživanja su opravdana za identifikaciju potencijalnih proizvoda raspada.

Ključne reči: Cink dioksid, monitoring, hemijska voda

Use of Zinc Dioxide Probes to Monitor Biological and Chemical Contamination of Water for Civil and Military Purposes

Abstract: Mainly organic pollutants, and their random wide application threatens human health and ecosystems. It is clear that detoxifying toxic insecticides from aquatic systems remains a global priority. In this study, a zinc oxide nanocatalyst with suitable properties was synthesized to achieve complete degradation of some insecticides from aqueous media. ZnO catalyst was used in normal and nano size as part of an advanced oxidation process in the presence of H2O2 and UV rays. The complete detoxification of the tested pesticides after treatment with the most effective process (ZnO(s)/H2O2/UV) was then investigated by biochemical treatment research. The effect of ZnO water treatment was also investigated. Interestingly, this study reported that the degradation rates of the investigated insecticides were faster using nano-sized ZnO catalysts than plain ZnO catalysts as well as zinc dioxide probes. In this sense, complete decomposition of the investigated insecticides (100%) in the ZnO(s)/H2O2/UV system was achieved after 320 min of irradiation. Water treatment with zinc oxide nanocatalyst improved the quality of water parameters. Together, the advanced oxidation processes using ZnO nanocatalyst can be considered as a promising treatment technology for the complete detoxification of methomyl and dimethoate in water. However, further research is warranted to identify potential breakdown products.

Keywords: Zinc dioxide, monitoring, chemical water

1. Introduction

Characterization of Commercial and Fabricated ZnO Figure 1 shows typical scanning electron images of synthesized and commercial ZnO. The results show that the shape of the synthesized ZnO is spherical with a diameter in the range of 30–49 nm. Commercial ZnO appears as randomly oriented

hexagonal prisms with diameters ranging from 34 to 119 nm and lengths ranging from 169 to 399 nm. Additional studies on the structures of synthesized and commercial ZnO were conducted using transmission electron microscopy.

The diameter of the synthesized ZnO(s) lies in the range of 12.48–26.12 nm. It reflects the shape of commercial ZnO which appears as a (nanowire) with a hexagonal diameter in the range of 30–83.87 nm with a length in the range of 70.96–406.45 nm. XRD diffraction pattern of ZnO nanoparticles. The peaks are indexed as 31.4° (100), 34.54° (002), 35.90° (101), 56.27° (110), 62.54° (103), and 67.64° (112). All the diffraction peaks of the sample correspond to the characteristic hexagonal virzite structure of ZnO nanoparticles; diffraction data file. The average particle size of ZnO nanoparticles was found to be in the range of 34–39.7 nm using the Scherrer equation. Diffraction patterns were found to be absent, corresponding to impurities. This proves that pure ZnO nanoparticles have been synthesized. However, the XRD patterns of nanoparticles are greatly extended due to the very small size of these particles. Strong and narrow diffraction peaks indicated that the product had good crystallinity. Particle size calculations using the Debie–Sheerer equation revealed that the average of commercial ZnO ranges from 61.66 to 75.8 nm. Figures 4A,B show the FTIR spectra of the synthesized ZnO (NPs). Infrared studies were conducted in order to determine the purity and nature of the metal nanoparticles. Metal oxides generally give absorption bands in the fingerprint region, i.e. below 1,000 cm−1, which results from interatomic vibrations. The peaks observed in Figure 4A at 3455 and 1.083 cm−1 may be due to O-H stretching and strain, respectively, attributed to water adsorption on the metal surface. The peaks at 1634 and 537 cm−1 correspond to stretching and straining Zn-O vibrations, respectively. The metal-oxygen frequencies observed for the corresponding metal oxides are in agreement with the literature values.

The figure shows the observed peaks of the received commercial ZnO (nanoparticles); two peaks at 3441 and 1.089 cm−1 may be due to O-H stretching and strain, respectively, assigned to adsorbed water on the metal surface. The peaks at 1631 and 537 cm−1 correspond to Zn-O stretching and deformation vibrations, respectively.

Figure 1. SEM image and particle size distribution of synthesized (A) and commercial (B) ZnO.

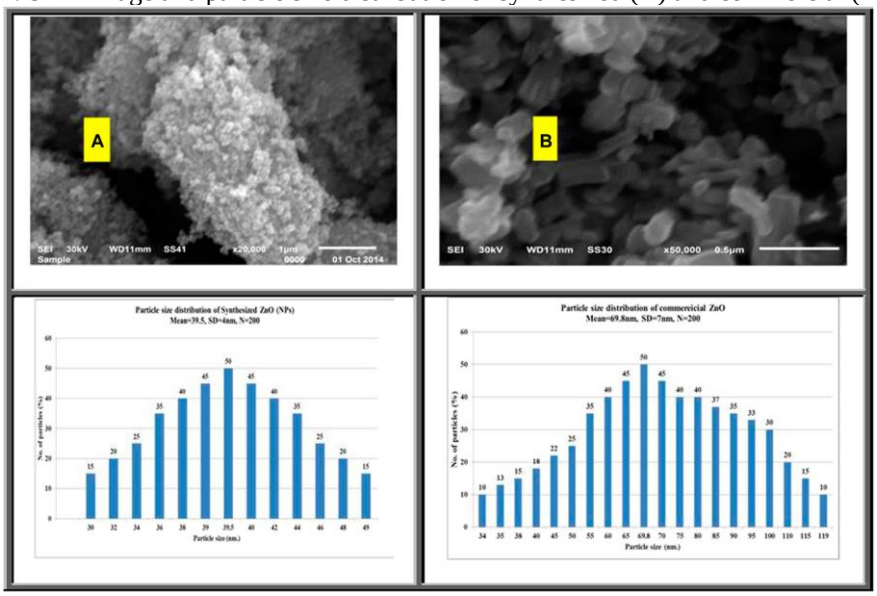


Figure 2. TEM image of synthesized (A) and commercial (B) Zn

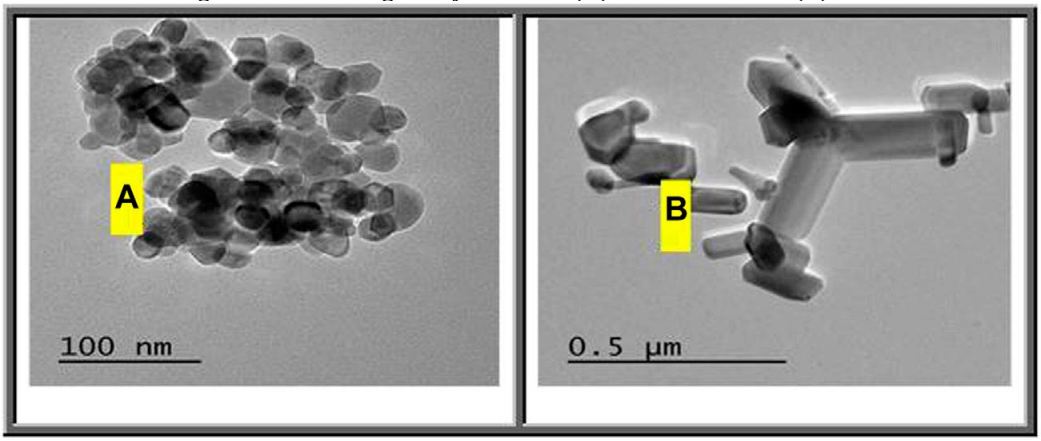
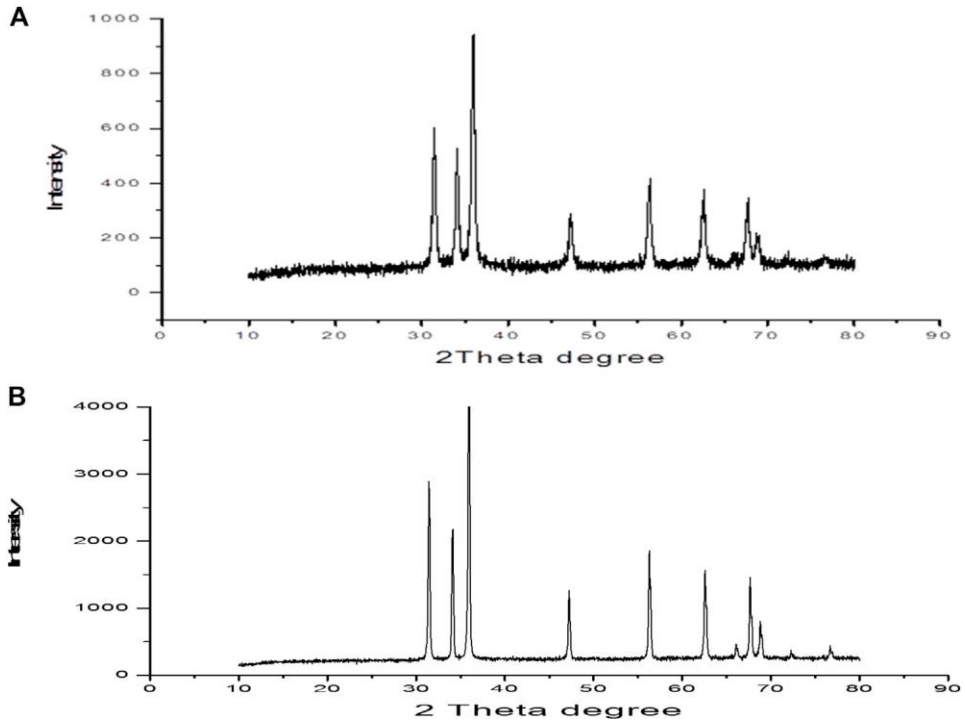


Figure 3. XRD samples of manufactured and commercial ZnO.



2. Intake of heavy metals through water

Soil is polluted by the presence of heavy metals in surface and groundwater, and pollution increases when mined ores are dumped on the surface of the soil for manual processing.

Due to deposition over the surface, the metals(Gnamuš A, Byrne AR, 2000) are exposed to air and rain, thus creating massive AMD. If the soil is polluted at that time, it enters the plant tissue and accumulates there. And when those plants are grazed by animals and water is used for drinking from polluted waters, these heavy metals enter the body through them. Also, marine life, which reproduces in contaminated water, also has the presence of heavy metals in their body tissues, if they are lactating then in their milk. As an overview, all organisms within a given ecosystem are contaminated by these pollutants (Atmos. Environ., 2005) through their food chains. When food is taken from these contaminated vegetables, the presence of heavy metals in those vegetables can lead to various chronic diseases. The toxic effects of these heavy metals usually depend on the amount of concentration and the oxidative state of certain heavy metals. Heavy metals have a very dangerous impact because they are non-degradable in nature, have a long biological (Hines ME., Faganeli J, 2006) half-life and have

the potential to accumulate in the body. Also, there are some heavy metals that are extremely toxic just because of their solubility. Smaller concentrations of heavy metals within the food chain also show serious effects because there is no specific procedure by which these heavy metal contaminants can be extracted from the organism's body. Today, the presence of these toxic heavy metals is everywhere due to their extreme industrial use. In the case of wastewater, it contains a huge concentration of heavy metals, which create various health problems.

2.1 Impact on the aquatic environment

Water from estuaries and fresh water has not been somewhat polluted so far, but even that water threatens to be polluted in the long term due to the deposition of metals due to human past activities. Water in rivers and lakes can be highly polluted depending on the volume (Jeran Z, Jaćimović R, 2002) of flow and the proximity of point sources. Due to human civilization, the content of elements in water has increased. Such elements are cadmium, lead, mercury, zinc and chromium. Unlike organic chemicals, there are metals that cannot be converted into less toxic compounds, and one of their characteristics is the loss of biodegradability. When heavy metals enter the water system, they redistribute through the column and accumulate in the sediments. Sediments represent a partial contribution to the pollution of natural phenomena due to their activity and metal remobilization process. Metal residues present in the contaminated environment have the flexibility to bioaccumulate in the aquatic environment. The growth of larvae and young fish is fast. But when these heavy metals enter, they can inhibit the growth rate. Fish grow in length and bulk when given the right conditions, such as a certain temperature and an acceptable amount of food. On the other hand, fish growth can be hindered in water contaminated with poisons, such as heavy metals. One of the most noticeable signs (Schood Jožef Stefan, 2010) of metal toxicity in larval fish is growth inhibition. As a result, fish length and mass are indicators of environmental conditions. Heavy metals are introduced in liquid form, and the ingredients of surface water (carbonate, sulfate, organic substances humic, fulvic and amino acids) cause the formation of insoluble salts or complexes. These salts and compounds are not expected to harm aquatic species. Some of them sink and accumulate in the sediments at the bottom. A decrease in the pH of water due to acid rain or any other acidic incident, due to the deposition of heavy metals in the water column, causes the aquatic biota to become toxic. Low levels of heavy metals can also cause chronic stress, as fish may not die, but may cause them to lose weight and become smaller, reducing their capacity to compete for food and habitat.

3. Conclusion

The results of measurements in different parts of the environment show that mercury is present in very high concentrations in soil and sediments. Active transport of inorganic mercury takes place. The expected decrease in the concentration of mercury in biota since the closure of the Mercury Mine was not observed. Mercury concentrations in bioindicators are elevated in the vicinity of Idrija, but not to the extent of causing noticeable adverse effects. However, it must be noted that a change in land use and water management (such as the construction of a new hydroelectric power plant on the Idrijca River) can seriously alter the reactivity and formation of MeHg. An optimized monitoring program should therefore be implemented using physical, chemical and biological methods, and in particular appropriate biomonitoring to detect changes in the mobility, reactivity and bioavailability of mercury.

4. Literature

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