Microwave assisted photocatalysis of mono-chloroacetic acid over nanoporous titanium (IV) oxide thin films

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Microwaves are well known for their heating effects on polar substances and are widely used domestically and industrially. Recently, microwaves have been used to assist photochemical and photocatalytic reactions for degradation of organic pollutants [1]. As source of light was used an electrodeless discharge lamp (EDL) which generates ultraviolet (UV) radiation after placed into microwave field [2, 3]. The preparation of EDL was described elsewhere [4]. Comparative studies showed that EDL provides a high yield of product in shorter reaction time [5, 6].

TiO_2 sol was prepared by hydrolysis of titanium tetraisopropoxide according to the method described by Kluson et al. [7]. Hydrolysis was carried out in the reverse micelles of Triton X-100 in cyclohexane. The film was prepared by dip-coating of pretreated support into TiO_2 sol. The film was finalized by thermally treatment at 673 K after each coating cycle. The crystal phase of titanium dioxide was analyzed by XRD. The observed structure phases revealed anatase as the predominant crystalline phase. The crystallite size of the sample was estimated under 10 nm. Specific surface area was determined from adsorption of nitrogen. The absorption edge was detected by UV-Vis spectrophotometer at a wavelength of about 364 nm. From AFM images we can recognize homogeneous film of TiO_2 with approximately uniform crystallite size.

Experimental set-up is consisted of round-bottom flask equipped with Dimroth condenser. In each experiment, the reactor was filled with an aqueous solution of mono-chloroacetic acid (MCAA). Then the coated EDL was placed into the reaction mixture and microwave field induced UV radiation. Samples were taken with syringe from reactor after every 20 minutes and analyzed by chloride ion-selective electrode. Another experimental arrangement was a glass tube equipped with external condenser. One, two or three coated EDLs were placed into the glass tube. The solution of MCAA was circulated by pump and reaction temperature was varied from 35 °C to 90 °C.

The dependence of number of coating cycles, UV light intensity and temperature was tested. There is no dependence between number of coating cycles and efficiency of photocatalytic reaction. The best results were obtained with lamp of highest intensity.

In this work, we submit another possibility how to carry out the photocatalytic reactions. This special arrangement of photocatalyst and source of light provides complete utilization of TiO_2. There is no problem with recovery of powder photocatalyst from solution. We suppose shorter reaction time and high efficiency of microwave assisted photocatalytic reactions.

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