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BENZENE PHOTODESTRUCTION USING TI-CONTAINING CATALYSTS ON METALLIC SUPPORTS

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Very important problem nowadays is the industrial wastewater purification. Aromatic hydrocarbons (phenol and benzene, in particular) are the most common pollutants. Photocatalysis is one of the environmental friendly technologies for the reprocessing of toxic pollutants directly under the influence of solar radiation. It is known that titanium dioxide is one of the most studied and active photocatalyst. The main disadvantage of this catalyst is adsorption only UV-irradiation (i.e., wavelength<388 nm) . For the purpose of activity shift to the visible radiation range the intensive researches on TiO_2 doping by various elements including nitrogen are carried out. On the other hand the use of TiO_2 in the form of fine powder is a technological drawback. The solve of this problem may be related to the use of various supported TiO_2-containing catalysts. Synthesis of the supported on Aluminium foil and AISI 321 stainless steel foil (thickness 80 μm) composites was carried out by low temperature ion implantation method. Ti was used as an implant. The cathode sputtering of the target (Ti) was carried out by N_2 ions. The energy of implantation is 20 keV at a dose of $5x10^{17}$ ions/cm^2. The obtained samples were calcinated on air in the temperature range of 200-400 °C. The surface composition and the effect of calcination temperature were characterized by XRD, SAXS, SEM, AFM, and XPS. It was shown that as a result of ion implantation of Ti on the surface of a stainless steel, a nanosized layer of the implant is formed, in the form of amorphous composition consisting of oxide, nitride and titanium oxynitride. Hypothesis of active phases on the surface of support is expressed, which ensures its high activity in the reaction of photodegradation of an gaseous benzene under UV and visible light irradiation.

Photocatalytic properties

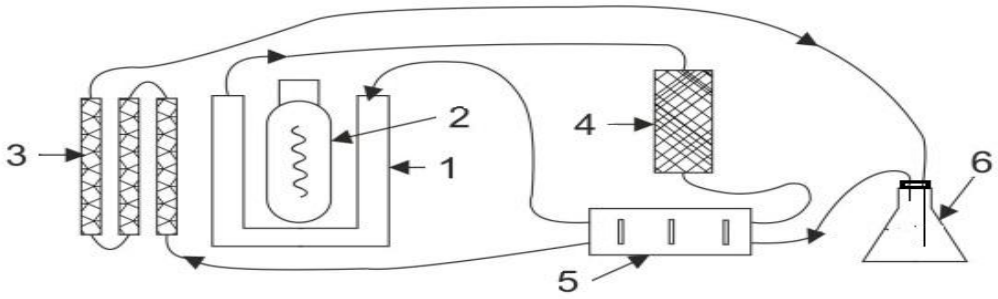
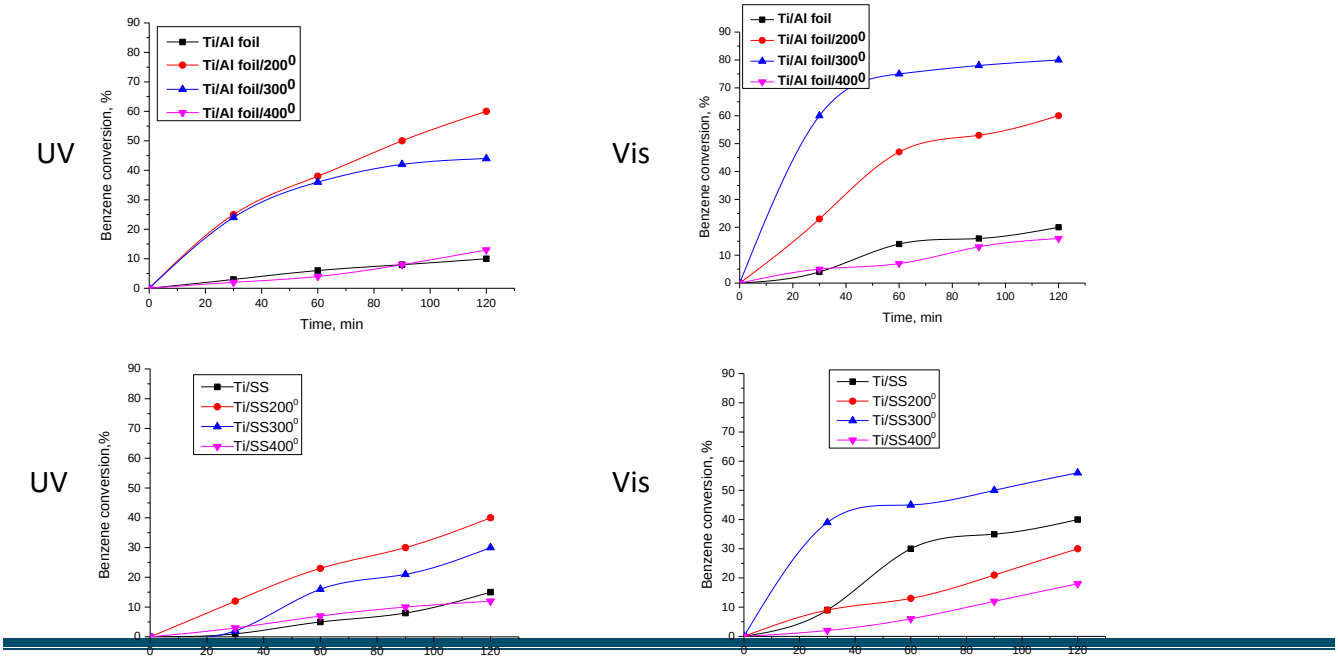


Figure 1. The photocatalytic installation for gaseous mixtures: 1 – cooling jacket, 2 – irradiation source (UV- or VIS-lamp), 3 - system of the catalyst filled quartz tubes connected in series, 4 – cooling water, 5 – peristaltic pump, 6 – gas mixture with pollutant

The activity of synthesized samples was determined in the reaction of photodegradation of gaseous benzene (130 threshold limit values (TLV)). The high pressure mercury or sodiumlamps were used as a source of radiation. The reaction products were analyzed with a SelmiChrom-2 gas chromatograph equipped with a FID on a stainless steel column (length 1 m, diameter 3 mm) filled with Porapak Q. The presented results show that the activity of practically all synthesized samples at both UV irradiation and visible light irradiation is observed. In the case of UV-irradiation samples after treatments at 200 and 300°C have the maximum activity . At visible light irradiation the most active catalysts are the initial implanted sample Ti/SS and Ti/SS300, Ti/Al foil200 and Ti/Al foil300. Further temperature treatment reduces the catalyst photoactivity. Those kinds of changes in samples activity can be explained with influence of temperature on the ratios between nitride, oxynitride and oxide phases of the titanium. The thermal treatment leads to TiO_2 phase formation and it has negative effect on samples properties. According SEM data an increase of the treatment temperature leads to the subsequent agglomeration of the part of supported titanium layer with formation of new spherical particles.

Photodegradation of gaseous benzene



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THE INFLUENCE OF TiO_2 MODIFICATION ON ITS ADSORPTION AND PHOTOCATALYTIC PROPERTIES

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Titanium dioxide is widely used in photocatalysis in particular for the destruction and mineralization of organic and inorganic pollutants. It is a cheap and non-toxic catalyst. The main factor controlling photoactivity of titanium dioxide is the high degree of recombination of photogenerated electrons and holes. But the electron-hole pair can also have an average lifetime that is sufficient for diffusion to the surface of the particles. This enhance photon absorption and increase the number of electron-hole pairs. On the other hand, the lifetime of an electron-hole pair can be affected by the number of recombination sites on the photocatalyst, which can be various impurities, defects of the crystal structure etc. Recently, great attention has been focused on the development of efficient catalysts based on TiO_2 and non-metal as dopants for the degradation of organic pollutants in aqueous medium.

In the current research, we synthesized a row of nanocomposites based on titanium dioxide, carbon and sulfur (TiO_2, C/TiO_2, S/TiO_2 and $C/S/TiO_2$) with different content of dopant (C or S). Photocatalytic activity of nanocomposites was evaluated through the degradation of cationic dyes Safranine T and Rodamin B under UV and visible irradiation, as model reactions. These dyes are stable in the environment.

The nanocomposites were characterized by X-ray diffraction, scanning electron microscopy, energy-dispersive spectrometry, transmission electron microscopy, Brunauer–Emmett–Teller and Barret–Joiner–Halenda methods, UV-vis diffuse reflection spectroscopy, Fourier transform infrared spectroscopy.