GAS-PHASE PHOTOCATALYTIC OXIDATION OF VOCs ON THE TIO_2 THIN FILMS

Jekaterina Sydorenko[1], Mati Danilson[1], Arvo Mere[1], Malle Krunks[1], Marina Krichevskaya[1] and Ilona Oja Acik[1]

1. Department of Materials and Environmental Technology, Tallinn University of Technology, Ehitajate tee 5, 19086 Tallinn.
e-mail of presenting author: jekaterina.spiridono@taltech.ee

The aim of the current study was to synthesize photocatalytically active TiO_2 thin film by increasing the amount of acetylacetone (AcacH) molar ratio in precursor solution and study the gas-phase photocatalytic oxidation of different VOCs (acetone, acetaldehyde, heptane and toluene) under ultraviolet (UV) and visible (VIS) light on the obtained films. The effects of initial concentration, air flow rate and relative humidity (RH) on the photocatalytic oxidation of the pollutants were investigated.

TiO_2 films were deposited by spray pyrolysis technique. According to our previous study precursor solutions with titanium (IV) isopropoxide (TTIP): Acetylacetone (AcacH) molar ratios 1:5 and 1:8 were used for the TiO_2 films prepation. Films were characterized by X-ray diffraction, UV-VIS, spectrophotometry and X-ray photoelectron spectroscopy (XPS). Photocatalytic activity of the films was studied in multi-section plug flow gas-phase reactor. The photooxidation of VOCs at different operating conditions was studied separately and in the mixtures.

Both films consist only of anatase crystalline phase, showed the transparency of ca 80% in the visible spectral region and a band gap is ca 3.4 eV. XPS results demonstrated that films with higher AcacH amount in spray solution contain more adsorbed carbon on the surface, which probably lead to a changes in electronic structure and resulted in a better photocatalytic activity.

At first, the activity of the films in the gas-phase was studied by degradation of pollutants with simple molecular structure - acetone and acetaldehyde. An increase in the TTIP:AcacH molar ratio from 1:5 to 1:8 led to the enhance of gas-phase photocatalytic activity of the film in degradation of both acetone and acetaldehyde about two times. Then, film with TTIP:AcacH molar ratio 1:8 was studied for its ability to oxidize more refractory compounds such as heptane and toluene. Results showed that under UV-A 10 ppm of heptane were completely oxidized at catalyst surface area of 360 cm^2 and conversion of toluene achieved at catalyst surface area of 600 cm^2 was about 60%.

TiO_2 thin film with TTIP:AcacH molar ratio 1:8 due to increased amount of organic in precursor solution showed promising ability of indoor air purification from VOCs.

Euroopa Liit
Euroopa
Regionaalarengu Fond

Eesti
tuleviku heaks