NATIONAL CENTER FOR SCIENTIFIC RESEARCH
“DEMOKRITOS”

Institute of Nanoscience and Nanotechnology
"Nanofunctional and Nanocomposite Materials Laboratory"

PHOTOCATALYTIC PERFORMANCE OF THE SAMPLES FROM NANOPHOS COMPANY (LABORATORY MEASUREMENTS)

ISO 22197-1

Agia Paraskevi, April 2015

CONTENT

1. Introduction

Removal of air pollutants from the atmosphere including nitrogen oxides NOx is a typical application of photocatalysis [1] that has been evolved in a standard procedure for photocatalytic activity evaluation of the materials. Nitric oxide (NO) is chosen as a typical air pollutant that gives nonvolatile products on the photocatalyst surface. NO is adsorbed on the surface of photocatalyst and is converted to nitrogen dioxide (NO_2) and then to nitrate ions (NO_3^-). The present report concerns the measurement results on photocatalytic activity of a photocatalytic sample provided by NANOPHOS Co, Greece. The samples were investigated for oxidation of NO pollutant at the "Nanofunctional and Nanocomposite Materials Lab", Institute of Materials Sciences, NCSR Demokritos. The study includes:

- measurements of the NO monoxide,
- measurements of the NO_2 dioxide,
- determination of NOx removal.

2. Experimental evaluation

The investigated sample Ö was a cement-board with photocatalytic coating SurfaShield C applied at 8 m^2/L consumption rate. The dimensions of the surface exposed to UV illumination were 99.1 mm x 49.1 mm. The side edges of the samples were sealed with non-photocatalytic epoxy varnish.

The NO oxidation process described in details in [2] was monitored using HORIBA 370 chemiluminescent NOx analyzer and standard procedure based on ISO/DIS 22197-1 [3]. At the beginning, residual organic contaminants on the surface of the films were eliminated by samples' exposure to UV illumination with intensity ~ 10 W/m^2 for 72 h. After the cleaning procedure, the samples were placed in a home-made flow-type photocatalytic reactor. Their photocatalytic activity was evaluated under UV-A light illumination with intensity 10 W/m^2. The duration of the experiments was ~ 5 h. The NO gas was supplied from gas container with 50 ppm NO concentration in N_2 (Linde Hellas). The NO concentration in the reactor was adjusted to 1 ppm and the relative humidity was kept at 50 % using dry and wet air. The gas flows were controlled by Bronkhorst gas mass flow meters. The NO gas flow rate over the samples was approximately 3L/min. Under UV illumination, NO gas was adsorbed on the surface of photocatalysts and successively oxidized to NO_2 gas first and then to nonvolatile nitrates. The NOx concentration in the air was retrieved by the

summation of NO and NO_2 concentrations. The air purification performance of the photocatalysts can be determined taking into account the overall amount of nitrogen oxide gases that were removed from the gas phase (1 (ppm) – NOx (ppm)). The adsorption and desorption of NO by the investigated samples (not due to photocatalysis) was evaluated by tests in the dark for 10 min time interval.

3. Measurement results

The measurement results are presented in Figure 1 below. Initially, an adsorption-desorption equilibrium of NO (NO_x) gases at ~1 ppm was reached over the photocatalyst in the dark. A shallow "dive" represents the adsorbed quantity of NO on the photocatalyst surfaces in the dark.

When the UV-A illumination was switched on, the NO and NO_x concentration dropped sharply at the first moment. After stabilization (time period ~ 30 min), the NO concentration slightly decreased while NO_2 concentration slightly increased with a result the NOx removal remained practically constant till the end of the illumination period.

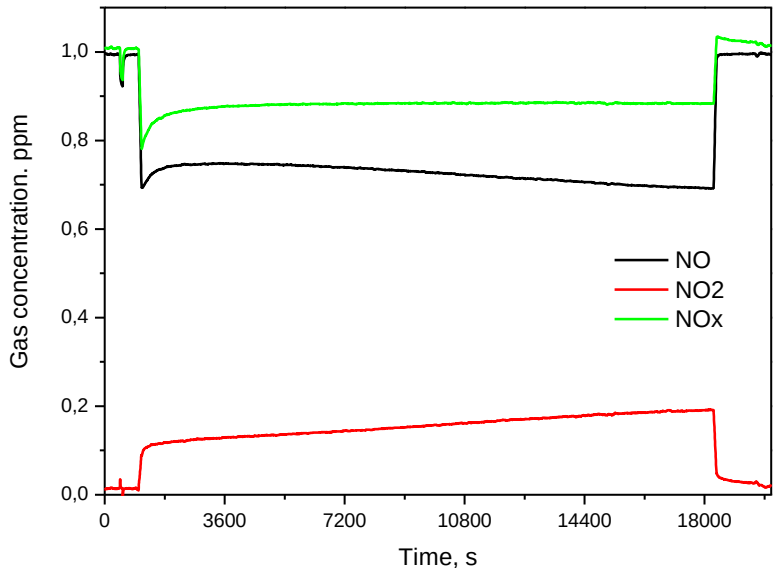

Figure 1. Recorded gas concentrations under UV irradiation for sample Ö.

The detailed measurement data are shown in Table 1. There, the results for gas concentrations are presented in the beginning of the UV illumination after an abrupt

alteration and 30 min stabilization period of the gas concentrations and in the end of the illumination period. The calculated values of the NOx removal (1 – NOx) in the end of the illumination are given in Table 2. The results are presented in %.

Table 1. Measurement results in the beginning (30 min after light switching on) and in the end of the ~ 5h illumination period

Sample	NO concentration (ppm)		NO_2 concentration (ppm)		NOx concentration (ppm)	
	Start	End	Start	End	Start	End
Ö	0.75	0,69	0.12	0.19	0.87	0.88

Table 2. Calculated values of NOx removal in the end of the illumination period

Sample	NOx removal (%)
Ö	12

4. Conclusion

- The investigated sample Ö from NANOPHOS with photocatalytic material exhibited stable photocatalytic activity in NOx removal during 5h illumination period.
- The sample revealed production of NO_2 gas not higher than 20%.

5. References

[1] T. Ibusuki and K. Takeuchi, Removal of low concentration nitrogen oxides through photoassisted heterogeneous catalysis, *J. Mol. Catal*., 88 (1994) 93-102.

[2] T. Giannakopoulou, N. Todorova, G. Romanos, T. Vaimakis, R. Dillert, D. Bahnemann, C. Trapalis, *Mater. Sci. Eng. B* 177 (2012) 1046– 1052.

[3] ISO/DIS 22197-1, 2007. Fine ceramics (advanced ceramics, advanced technical ceramics) - Test method for air-purification performance of semiconducting photocatalytic materials. Part 1: Removal of nitric oxide, pp. 1–11.

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