Smart Building Materials for Remove of VOC Pollutants from Environment (Indoor/Outdoor)

Niaei Parvaneh^{1, 2}, Mirmohseni A. R.¹, Niaei A.³

Polymer Tech & Surface Chemistry Res. Lab., University of Tabriz, Tabriz, Iran, Email: mirmohseni@tabrizu.ac.ir Department of Architecture, Azad University of Tabriz, Tabriz, Iran, Email: parvanehniaei@gmail.com

Catalyst Res. Lab., Department of Chemical Engineering, University of Tabriz, Tabriz, Iran,

Email: aniaei@tabrizu.ac.ir

Abstract

This paper was focused on the surrounding design of environmentally responsible buildings. The design of the building envelope and the building fabric will affect the comfort conditions and depollution of environment (indoor/outdoor). External building surfaces (i.e. tiles, ceramic, glass, and so on), are ideal places to be modified with photocatalysts to get an additional depollution function due to availability of sunlight.

The innovative technology is dedicated to decompose gaseous pollutants using photocatalysts under illumination of UV or solar light without extra energy added. Heterogeneous photocatalytic oxidation (PCO) is one of the most active research areas in environmental indoor/outdoor air purification.

A number of studies focused on the application of TiO2 modified building materials and components, such as paints, wall paper, tile, and windows. For the technology of air-cleaning building materials or concrete pavement, various gaseous contaminants, including NOx, volatile organic compounds (VOC), and so on, as well as particulate matter, such as carbon soot, have been tested as challenge contaminants to examine the photocatalytic degradation performance.

The objective of this study is the generation of metal oxide coupled with TiO2 photocatalysts (Transition metal Mixed oxides /TiO2) that exhibit enhanced photocatalytic activity compared to the non-modified one on the commercial surfaces such as tiles, glasses and stones.

In this experimental work, various scales and other related research, such as coating techniques, and testing methods, are discussed and evaluated separately for PCO air cleaners on the different building materials such as tile, glass and stones. Samples were prepared with sol-gel and dip-coating methods. It was found that coating techniques affected the performance of photocatalytic activity.

The VOC photocatalytic degradation was obtained utilizing flat plate samples in a cylindrical photo reactor. Different light source was used. The inlet gas was a mixture of air with volatile organic compound such as toluene and soot. The concentration of the outlet gas was measured using a gas chromatography analyzer (GC Shimadzu 2020). The photocatalytic activity of the plates was conducted in a reactor described in detail in the paper. The surface area of irradiated samples was kept constant.

Additions of Ag- TiO2/mixed oxides photocatalyst to building materials results in the abatement of pollutants found in air, and self-cleaning effects avoiding the soot and organic materials attached to the building surface. Conversion efficiencies of VOC depollution of above 30-60% for different surface were observed. The coated stone, tile and glasses with different additives, characterized by the aid of FESEM, X-ray diffraction analysis to study the structure and morphology of the tested samples.

Keywords: Self cleaning surfaces, Photocatalyst, VOC, Tile, Glass and Brick

Introduction

Air pollution is the introduction into the atmosphere of chemicals, particulates, or biological materials that cause discomfort, disease, damage other living organisms such as food crops, or damage the natural environment or built environment. Volatile organic compounds (VOCs) are of main air pollutants that widely present in both indoor and outdoor environments. The main emission sources of VOCs are motor vehicle exhausts and solvent utilization and for the production of Nox the reaction of nitrogen and oxygen gases in the air during combustion, especially at high temperatures is the main reason (air-breathing engines). Because of increasing environmental concerns including their adverse effects on human health, acid rain, tropospheric ozone and ... VOCs elimination methods receiving an increasing amount of attention.