Photocatalytic Properties of TiO_2 Layers on Aluminium Substrates: Effect of Acid Pretreatment

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The population living in developed countries spends more than 90% of their time indoors [1]. The pollutants concentration in indoor air can be between two and five times higher than at outdoors [2]. Thus, the improvement of indoor air quality to ensure people's health has become in a need. A choice to solve that problem is the use of heterogeneous photocatalysis for air purification. Generally, for air treatment applications, the photocatalyst should be immobilized on a substrate [3]. Aluminium plates are interesting supports for designing photocatalytic devices due to their lightness, low price, easy shaping, and high ability to reflect the light. Nevertheless, aluminium raw materials are non-porous materials with low surface area. To improve the coating anchoring, resistance and mass transfer limitations, the modification of the surface properties is required. This work aims to develop highly efficient TiO_2 coating on aluminium plates to be use in a photocatalytic air decontamination unit. For this purpose, the effect of an acid pre-treatment, in the physico-chemical properties of the substrate and in the photocatalytic performance of aluminium/TiO_2 materials was studied. Substrates were dipped in hydrochloric acid aqueous solutions 2.0 M for different time, between 0-24 h. The TiO_2 layers were immobilized by dip-coating using a TiO_2 sol and by magnetron sputtering using a TiO_2 ceramic target. Raw materials and photocatalysts were characterised by UV-Vis spectroscopy, X-ray diffraction (XRD), SEM-EDX, and profilometry. Changes on the hydrophilicity-hydrophobicity of the surfaces were also analysed by contact angle technique. In addition, the photocatalytic performance towards the removal of an organochloride compound in airstreams was analysed. The variation of the pre-treatment time leads to a modification of the roughness of the substrate. A maximum photocatalytic efficiency was obtained for pre-treatment times between 4-6 h. Above this point a soft decrease in the photocatalytic efficiency was observed. The substrate roughness plays an important role in the photocatalytic properties. An equilibrium between the chemical attract phenomena to improve the roughness and porosity, and the formation of surface compounds should be balanced. Finally, to optimise the final photocatalytic configuration, the effect of the layer thickness on the optical and photocatalytic properties will be discussed.

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[1] J. D. Spengler y K. Sexton, Indoor air pollution: a public health perspective, Science, vol. 221, nº 4605, pp. 9-17, 1983.

[2] U.S. Environmental Protection Agency. 1987. The total exposure assessment methodology (TEAM) study: Summary and analysis. EPA/600/6-87/002a. Washington, DC.

[3] S. Suárez, Chap. 2. "Immobilised Photocatalysts", in "Design of Advanced Photocatalytic Materials for Energy and Environmental Applications" Eds. J. Coronado, F. Fresno, M.D. Hernandez-Alonso, R. Portela. ISBN: 978-1-4471-5061-9.