Self-cleaning and/or Air-purifying Cementitious Materials: Evaluation Method

Aníbal Maury-Ramirez

Supervisor(s): Nele De Belie, Kristof Demeestere

I. Introduction

At laboratory and in-situ scales, application of TiO_2 photocatalysis has proven to give new properties to cementitious materials such as self-cleaning and air-purification. However, in order to move forward to massive application, many technical aspects need to be improved and evaluated. Thus, development of fast screening tests methods based on the degradation of organic dyes applied on TiO_2 loaded materials under UV irradiation has become an important issue for the preliminary evaluation of the TiO_2 photocatalytic potential. In this paper an adaptation of a fast screening test method based on the degradation of Rhodamine B applied on TiO_2 added cement pastes under UV irradiation is briefly described and evaluated.

II. Test Methodology

UV irradiation is produced by a UV-cabinet C-75 (Ultra-Violet Products UVP, UK). UV intensity inside the cabinet ranges from 1.5 to 2.5 mW/cm^2, being of the same order of magnitude as can be expected during sunny days in Central Europe. Rhodamine B is the organic dye selected because this has an antracene moiety and as such is related to PAH (polycyclic aromatic hydrocarbons) which are among the most common soiling agents found in urban environments. Monitoring of Rhodamine B degradation is based on the red color change produced as consequence of the dye degradation on the tested samples under UV irradiation. This color change is monitored by using the parameter a* from the CIE Lab color space measured with a X-Rite SP60 colorimeter (X-Rite, USA). Measurements were taken on the tested samples before and after 4 and 26 hours of irradiation. Later, in order to determine if the TiO_2 loaded material has a significant photocatalytic potential for self-cleaning and/or air-purification, factors R_4 and R_{26} should be calculated as in (1) and (2).

$$R_4 = \frac{a^*(0h) - a^*(4h)}{a^*(0h)} * 100 \qquad (1)$$

$$R_{26} = \frac{a^*(0h) - a^*(26h)}{a^*(0h)} * 100 \qquad (2)$$

Finally, the material is considered as photocatalytic active, if the following conditions are fulfilled:

$$R_4 \geq 20\% \text{ and } R_{26} \geq 50\%$$

III. Results & Conclusion

As expected, after 26 hours of UV irradiation, cement paste samples containing the higher TiO_2 concentrations, showed more pronounced color changes while no significant color changes were produced on reference samples. By calculating R_4 and R_{26}, only samples containing 15% TiO_2 were nearly satisfactory to be considered as photocatalytic material.

In general, an existing fast screening method to determine the TiO_2 photocatalytic potential for creating self-cleaning and air-purifying cementitious materials was satisfactorily adapted and evaluated.

A. Maury-Ramirez works at the Structural Engineering Department, Ghent University, Ghent, Belgium. E-mail: anibal.mauryramirez@ugent.be