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OPTICAL CHARACTERIZATION OF ASPHALT MIXTURES IMPROVED WITH PHOTOCALYTICS

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In this communication the optical characterization of asphalt mixture improved by the incorporation of photocatalytic semiconductors is addressed. Road pavements must have the ability to resist the effects of climate and vehicle traffic ensuring safety comfort and economy with low environmental impact. The incorporation of photocatalytic into the asphalt gives it an extra ability to reduce the amount of important pollutants in air. The photocatalytic performance is evaluated by optical analysis using spectrophotometry, namely UV/visible diffuse reflectance and absorbance spectroscopies, allowing the calculation of the semiconductors' band gap and to analyze the photocatalytic activity by a dye degradation. Optical microtopographic inspection of the photocatalytic asphalt mixtures is performed to evaluate skid resistance of the pavements.

Introduction

Road pavements must have the ability to resist the effects of vehicle traffic ensuring good driving conditions but with low impact on the environment[1]. It is today possible to give asphalt new capabilities such as photocatalysis that allow the effective reduction of important air pollutants[2]. The semiconductor photocatalytic can be incorporated by spraying coating, bulk incorporation, bitumen modification, and spreading. The spraying coating technique, have been intensively studied since it is the most efficient one and uses less material[3]. Regarding the new capabilities, the photocatalysis, by the application of semiconductors onto the asphalt mixture, the photocatalytic performance is evaluated by optical analysis using spectrophotometry, namely UV/visible diffuse reflectance and absorbance spectroscopies, which allows the calculation of the band gap of the semiconductors and to indicate and analyze the photocatalytic activity by a dye degradation. The roughness and microtopographic[4] evaluation of these functionalized asphalt pavements is performed as it gives important insights about the performance of the pavement and particularly the skid resistance[5].

Discussion

Photocatalytic asphalt mixtures are obtained by the incorporation of semiconductors materials, such as TiO2 usually utilized at the nanometer scale and applied by using four main methods: spraying coating, bitumen modification, volume incorporation and spreading. When subjected to the action of light (optical interaction) the photocatalytic pavement breaks molecules of important pollutants in air. The semiconductor TiO2 activates the photocatalysis when it is irradiated with UV light from sunlight. In order to decrease the energy band gap into the visible range of the electromagnetic spectrum it was tested by implementing of a TiO2-doping process with different chemical elements, aiming to obtain an improvement in the photocatalytic efficiency in the visible range. The photocatalytic efficiency is usually evaluated by measuring the NOx degradation and monitoring over time the variation of the concentration of a particular organic dye. Several variables can influence the photocatalytic efficiency, such as pollutant flow rate and concentration, solar irradiation, humidity, and environmental temperature. In general, a high concentration of pollutants, high environmental temperature, high relative humidity, high gas flow rate, high traffic, and wind speed contribute to decreasing the photocatalytic efficiency. On the other hand, a high level of solar irradiation increases photocatalytic efficiency. In addition, the incidence of photons with higher energy becomes more effective than photons with longer wavelengths. In figure 1. is illustrated the photocatalytic efficiency evaluation. By applying the Beer-lambert law, the photocatalytic efficiency can be calculated from detected variations (decrease) in the maximum absorbance of the absorption spectrum acquired by optical spectroscopy. The microtopographic and rugometric characterization of the asphalt samples is performed using the MICROTOP.06.MFC microtopographer[4] on silicone replicas of the compacted asphalt mixtures (figure 2.).

Conclusions

Photocatalytic road pavements can be successfully produced. These new smart asphalt mixtures are very important since they can be used in places where there are high emissions of pollutants namely in areas with a high density of urban mesh contributing to improving the health conditions of the populations that live in or around urban centers.

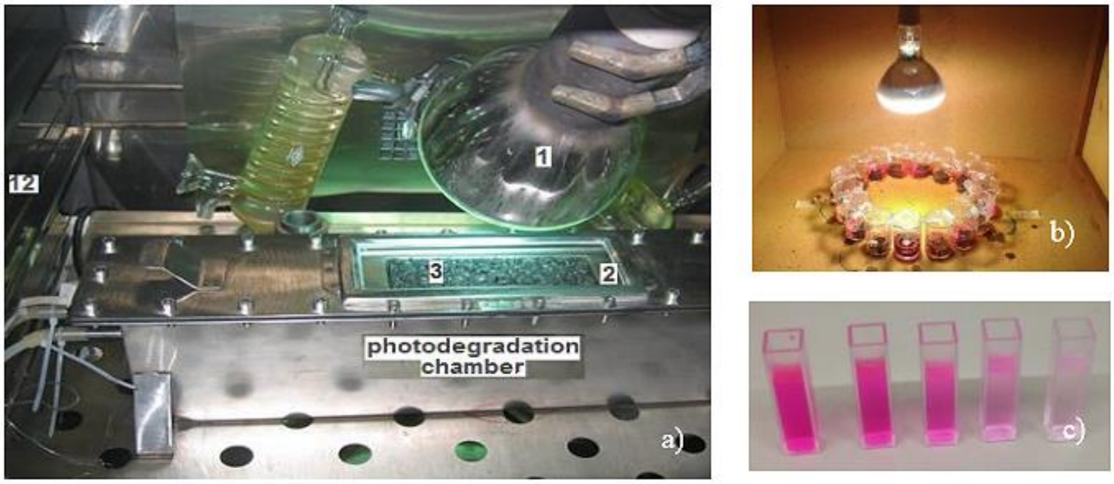

Figure 1: Tests for measuring the photocatalytic activity: a) NOx degradation efficiency; b) organic dye degradation; c) five samples with different color intensity showing the dye degradation level.

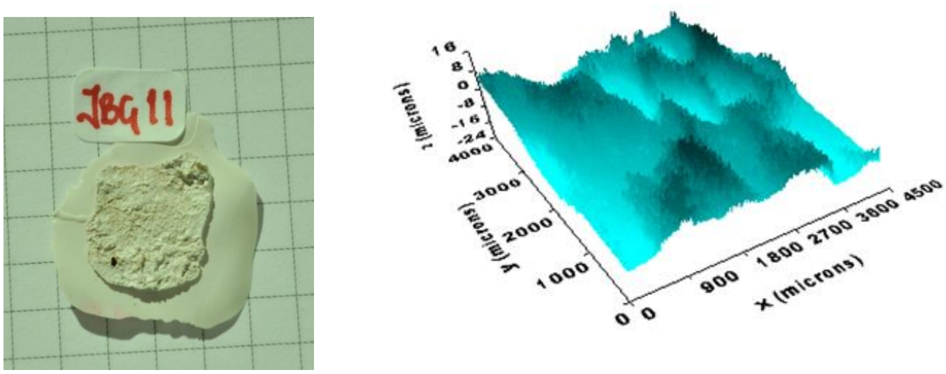

Figure 1. Example of the silicone replica of a section of an asphalt mixture and a partial 3D map.

Keywords: TiO_2; Photocatalysis; Asphalt; Skid resistance

Topic Code: Optics at Surfaces

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