# Evaluation of the photocatalytic activity of niobium oxide-containing coating

POSTER
Ph.D. Student: Y
Journal: ESPR

***LAC. Laqua***[1], *KL.Andrade*[1], *JS. Salla*[1], *SB. Canever*[1], *RFPM. Moreira*[1] , *RAF. Machado*[1] *(1). Federal University of Santa Catarina, Rua Engenheiro Agronômico Andrei Cristian Ferreira, s/n - Trindade, 88040-900, Florianópolis - SC, Brazil, leticia.costa@posgrad.ufsc.br*


Niobium oxide nanoparticles (0.5%, 1.0%, and 1.5% by mass) were incorporated into a commercial acrylic paint through mechanical dispersion. This mixture was then applied to fiber-cement plates to assess the photocatalytic activity of the coating by their ability to remove methylene blue dye and degrade oleic acid. The color removal of methylene blue dye from the surface of the plates was verified, both visually and by measuring the RGB index, while the degradation of oleic acid was investigated by contact angle measurements. The catalytic activity of niobium oxide in the discoloration of the plates was more pronounced in the plates containing 1.0 and 1.5% of niobium oxide. Moreover, the plate containing 1.0% of niobium oxide also showed the highest catalytic activity in degrading oleic acid,reaching contact angle values closer to those of the surface without oleic acid.

## Introduction

Coatings aim to protect and enhance surface properties, providing additional functionalities. Recently, nanomaterials have been used as additives in functional coatings, as their coatings exhibit high hydrophobicity and self-cleaning capabilities due to their photocatalytic activity [1,2].

Photocatalytic coatings stand out for their self-cleaning properties, allowing the removal of undesirable substances on the surface upon light exposure, significantly improving quality and structural appearance [1]. Niobium, a transition metal, has received considerable attention as a photocatalyst due to its notable electronic properties, including excellent chemical stability [3,4].

In this context, niobium and its compounds play a significant role in various industrial applications, including coating production. Given this scenario, this study aimed to evaluate the photocatalytic activity of coating containing different concentrations of niobium oxide.

## Material and Methods

Niobium oxide nanoparticles (0.5, 1.0, and 1.5% m/m) were incorporated into a commercial acrylic coating by mechanical dispersion using a Cowles disk at 2200 rpm for 20 min.

The photocatalytic activity of the coatings was evaluated by their capability to decolorize methylene blue dye and degrade oleic acid. The plates covered with coatings A, B, and C (0.5, 1.0, and 1.5% of niobium oxide, respectively) received two layers of 1 g $L^{-1}$ methylene blue solution and were left to dry for 48 h. After this period, the plates were exposed to UVB light (8 W) in a dark chamber, maintaining a fixed distance of 10 cm between the lamp and the plates. At certain times, the plates were photographed and the intensity of the red (R), green (G), and blue (B) colors were determined. The colors detected in the samples are compiled and transformed into RGB values, where each of these colors receives an intensity value that varies between 0 and 255. The closer the RGB measurement is to 255, the closer it is to the white color.

Identical plates also covered with coatings A, B, and C received sufficient oleic acid with a loading of 1.8 mg $cm^{-2}$. The samples were placed inside a dark chamber and exposed to UVB light (8 W) at a fixed distance of 10 cm between the lamp and the plates. The apparent contact angle of water in the air on the surface of the plates was measured in a Ramé-Hart 250 goniometer at room temperature. For each measurement, 5 µL of water and 3 different positions on the sample surface were examined to determine the average value.

## Results and Discussion

Figure 1 shows the change in the RGB index over time of exposure to UV light on plates A, B, and C. Generally, the red and green colors intensify, approaching white, while the blue color decreases due to the predominantly blue dye. There was a faster discoloration in paint coatings with 1.0 and 1.5% of niobium oxide, evidenced by the more significant increase in the RGB index compared to the coating containing 0.5% of niobium oxide.

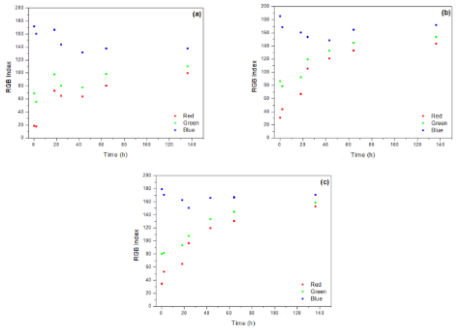

**Figure 1.** Evolution of the RGB index for plates A (a), B (b), and C (c).

Figure 2 shows the appearance of the fiber cement plates shortly after being impregnated with two layers of methylene blue and after 136 hours of exposure to UV radiation, highlighting the discoloration of the surfaces.

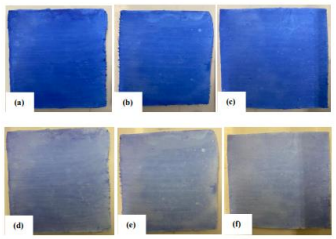

**Figure 2**. Plates A (a, d), B (b, e), and C (c, f) after receiving two layers of methylene blue and after 136 hours of exposure to UV radiation.

In the absence of oleic acid, the water contact angle on the surface of plates A, B, and C was 82.44 ± 0.18º, 63.53 ± 0.06º, and 74.99 ± 0.19º, respectively. A surface is considered hydrophobic when the contact angle value is greater than 90º and is considered hydrophilic when this value is lower than 90º. The nearly hydrophobic characteristic of the coatings was expected since the paint used as a base has a rubberized aspect, showing low interaction with water.

After the deposition of oleic acid, the water contact angle under the surface showed a decrease, assuming a more hydrophilic behavior. Through the exposure of plates A, B, and C to UV radiation, the photocatalytic activity of niobium oxide gradually degraded oleic acid, and the contact angle between water and the surface begins to increase again, returning close to its original value, that is when the surface did not contain oleic acid (Figure 3).

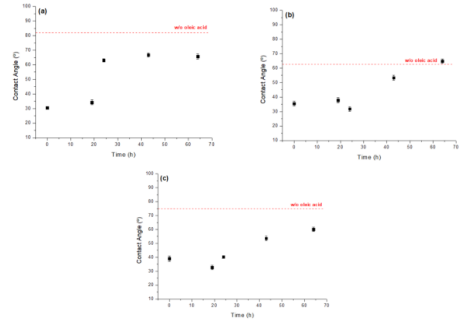

**Figure 3**. Evolution of the contact angle on plates A (a), B (b), and C (c).

Surface B, coated with the paint containing 1.0% of niobium oxide, is the first to reach its original contact angle value, indicating that the pollutant has been degraded from the surface after approximately 64 h of exposure to UV light.

## Conclusions

The fotocatalytic activity of niobium oxide incorporated into a commercial paint in different concentrations (0.5, 1.0, and 1.5% m/m) was investigated through the removal of methylene blue and degradation of oleic acid from the surface of coated fiber-cement plates. The catalytic activity of niobium oxide in the discoloration of the plates was more efficient in plates containing higher dosages of niobium oxide. The plate containing 1.0% of niobium oxide showed the highest catalytic activity among the plates investigated in degrading oleic acid, reaching contact angle values close to those of the surface without oleic acid more quickly.

***Acknowledgments***

This project has the financial support of CNPq, ANP (PRH 11.1), CAPES (project 001), and Anjo Tintas.

***References***

**[1]** VS. Mohite et al., *Catalysts*, 12(2022), 1.
**[2]** Q. Zhu. et al., *Materials Today Advances*, 15(2022), 100270.
**[3]** AK. Kulkarni et al., *Dalton Transactions*, 46 (2017), 14859 .
**[4]** BN. Nunes et al., *Catalysts*, 10(2020), 126.