XV International Conference on Durability of Building Materials and Components
DBMC 2020, Barcelona
C. Serrat, J.R. Casas and V. Gibert (Eds)

On Bio-Deterioration of Solar Reflective Materials: An Innovative Experimental Procedure to Accelerate the Ageing Process of Surfaces

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Keywords: *Solar Reflectance, Colorimetry, Bio-Deterioration, Bioreactor*

1 Introduction

Building materials are affected by several aesthetical and functional issues due to ageing processes which can be related to physical, chemical or biological factors (Sleiman et al., 2014). Among these factors, the biological growth represents a phenomenon in addition to physical and chemical problems due to weathering and soiling, which accelerates the fouling process of outdoor materials (Ferrari *et al*., 2015). Considering Solar Reflective Materials (SRM), bio-deterioration process takes part to important performances losses in terms of surface thermal properties, such as solar reflectance and thermal emittance. However, due to its the wide variability bio-deterioration is not yet being completely understood and quantify by the scientific community. Thus, this study is aimed to study biological colonization on building materials in a repeatable and reproducible way, in order to quantify the changes on the surfaces properties due to biological growth. An innovative and laboratory protocol to accelerate biological colonization effects on building surfaces is here presented.

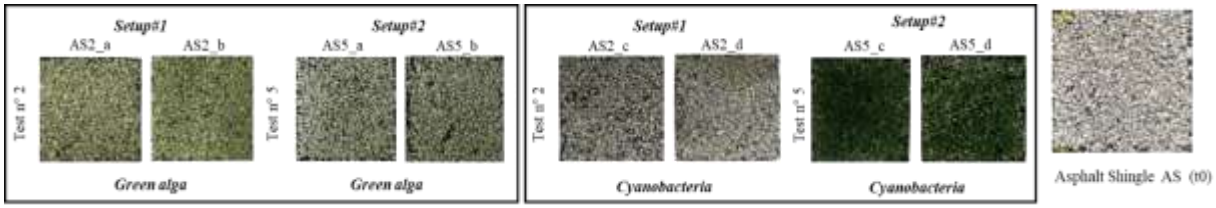
2 Material and Methods

The setup consists in a growth chamber, where all the environmental factors have been maintained constantly monitored and stable. The device chosen as growth chamber is a TIS (Temporary Immersion System) bioreactor (Welander *et al*., 2014). A complete bio-ageing cycle lasts 3 weeks and two types of building material were involved in this preliminary work: single ply cool white membrane (WM) and asphalt shingle (AS). Two samples for each type of material were included for each bioreactor, and each bio-ageing cycle was performed in triplicate in order to get statistically significant results. Two specie of different microorganisms were used separately: the green microalga *Chlorella mirabilis* and the cyanobacteria *Nostoc commune*. Two different sample submersion times were investigated: 10 minutes/6 times a day every 4 hours (setup #1) and 30 minute/6 times a day every 4 hours (setup #2): each time condition has been tested three repeated times as abovementioned. Surfaces have been characterized before and after bio-ageing process analyzing their microstructure with Environmental Scanning Electron Microscope, solar reflectance (ρ_{sol}) by UV-Vis-Nir Spectrophotometer, according with ASTM Standard E903 (ASTM E903, 1996), and L*a*b*

colorimetry. Statistical analysis by ANOVA (Past3 Software) has been run in order to evaluate the repeatability of the preliminary protocol.

3 Results and Discussion

Setup#1 trial shows a weaker but more homogeneous growth on materials samples then the



second set up trials, where the submersion time has been 30 minutes for 6 times a day (Fig. 1).

Figure 1. AS aged samples are shown: *a*-*b* samples (green alga inoculum) and *c*-*d* samples (cyanobacteria); the results test n° 2 and test n° 5 of 3 repeated tests by both setups types is shown; new (t0) sample are shown.

Solar reflectance values got on aged surfaces through two different TIS bioreactor submersion time (setup#1 and #2) highlight significant differences on both types of material, rising the strong variability among setups. Moreover, the colonization level due to green alga compared with the one due to cyanobacteria are significantly distant: they have been evaluated separately. ρ_{sol} decrease considering only AS, *a* and *b* samples, before and after bio-ageing process shows a good repeatability; the differences among ρ_{sol} on the same material type (AS or WM) from different trials are not significant (p-value >0.05).

4 Conclusions

This work provides a preliminary laboratory bio-ageing protocol suitable to study the bio-deterioration dynamics on building materials surfaces.

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