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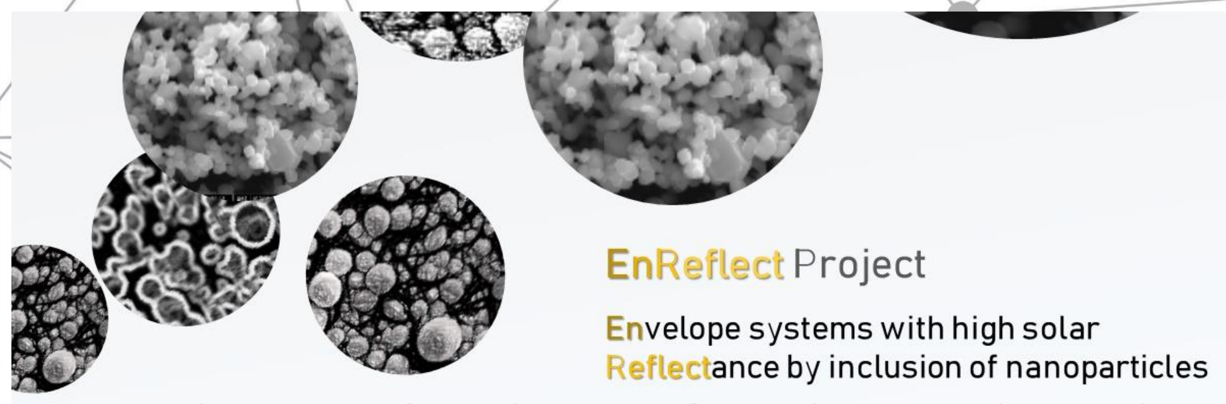

High reflective finishing coatings based on nanotechnology for optical improved façades

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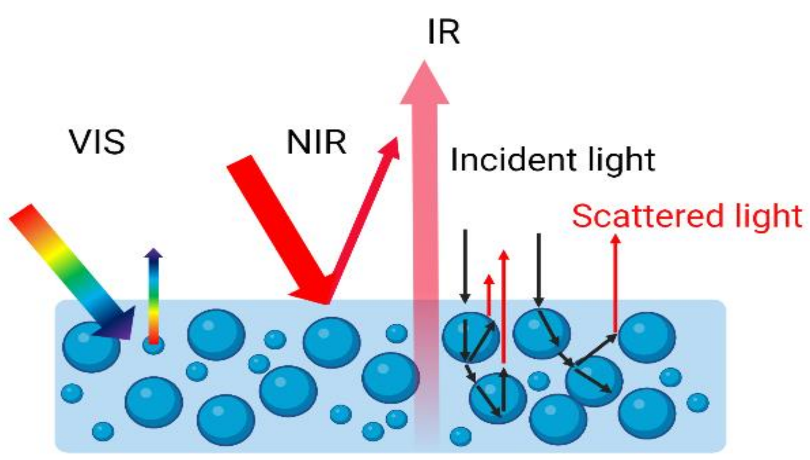
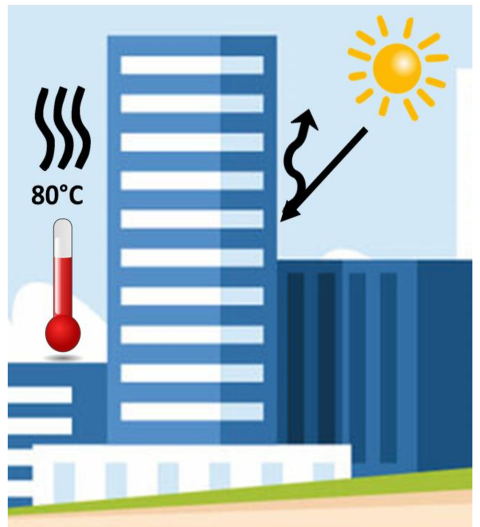
INTRODUCTION

Using adaptive materials in façades, such as reflective nanomaterials that can reduce the amount of absorbed solar energy in buildings, can be a promising solution to moderate the urban heat island effects. By integrating these materials into dark finishing coatings for external walls, solar energy absorption can be reduced, resulting in significant energy savings and enhanced occupant comfort. Several studies explore nanomaterials in coatings as these not only allow an effective control of the radiative properties, through the tuning of their optical properties, but also provide a path to improve resistance and durability of construction materials [1].





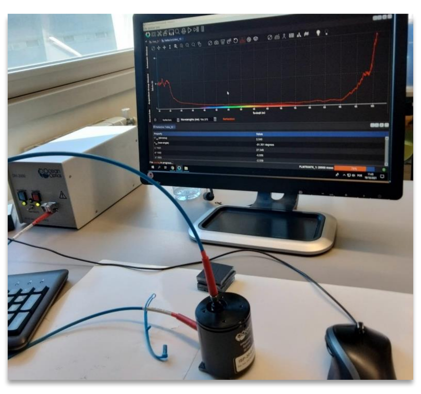
OBJECTIVES

Two types of nanomaterials, a commercial nanoparticle (NP), and a synthesized nanocomposite, were incorporated into a dark commercial finishing coating for External Thermal Insulation Composite Systems (ETICS). The optical properties [2, 3] and surface degradation, were evaluated and compared to the non-doped coating, before and after exposure to the heat-rain cycle, described in the EAD 040083-00-0404 [4]. The bio-susceptibility of the finishing coatings was also carried out according to ASTM D5590 [5] and ASTM C1338 [6], only before the accelerated ageing tests.

Non-doped | **Commercial NP** | **Synthesized NP**

Standard | **F1** | **F2**

Reflectance and colour



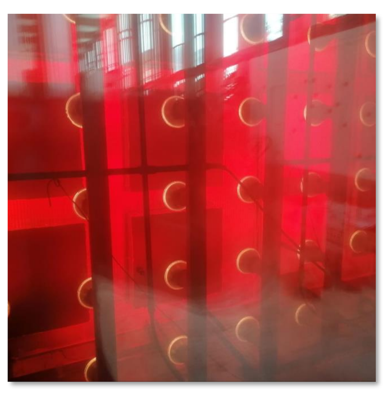
ASTM E903

$$\rho_s = \frac{1}{n}\sum_{i=1}^{n}\rho(\lambda_i)$$

ISO 11664-4

$$\Delta E^*_{ab} = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$$

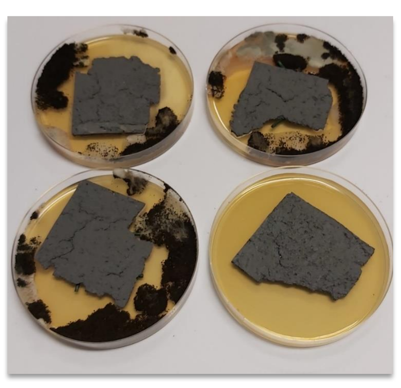
Accelerated ageing tests



EAD 040083-00-0404

Heat/ Rain Cycles

Bio-susceptibilty



ASTM D5590

ASTM C1338

RESULTS AND DISCUSSION

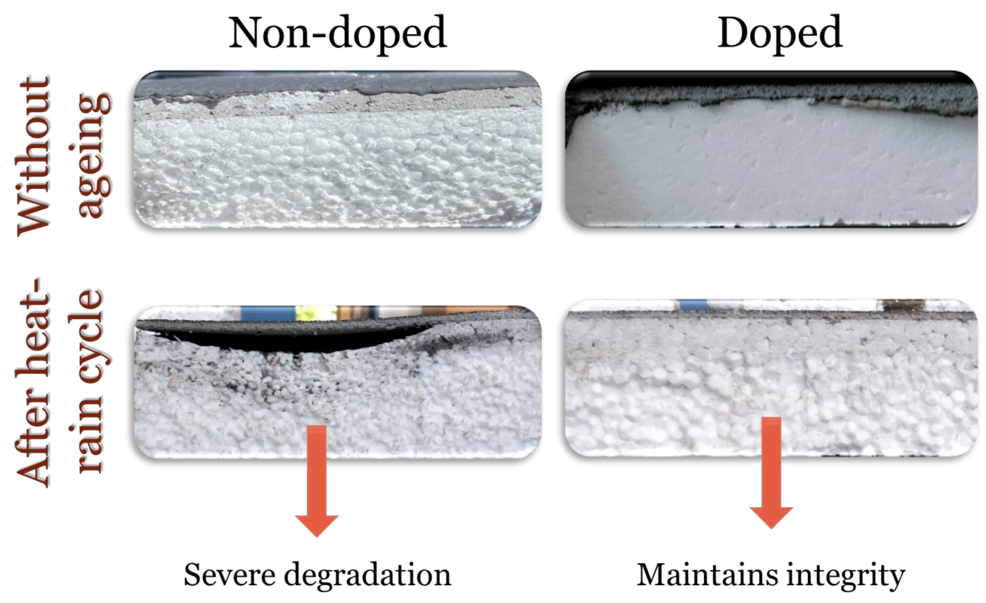
- **Surface degradation and bio-susceptibility**

After the heat-rain cycles the samples were evaluated by visual observation to analyze the degree of the system degradation. For the doped samples minimal degradation is observed maintaining the integrity of the insulation system.

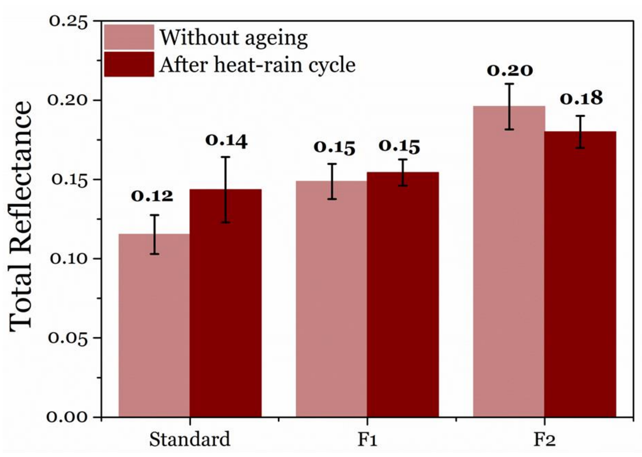
The analysis of the bio-susceptibility was performed by optical microscopy. Traces of mold growth were observed on the surface of all three samples. However, F2 samples were less susceptible to mold development.

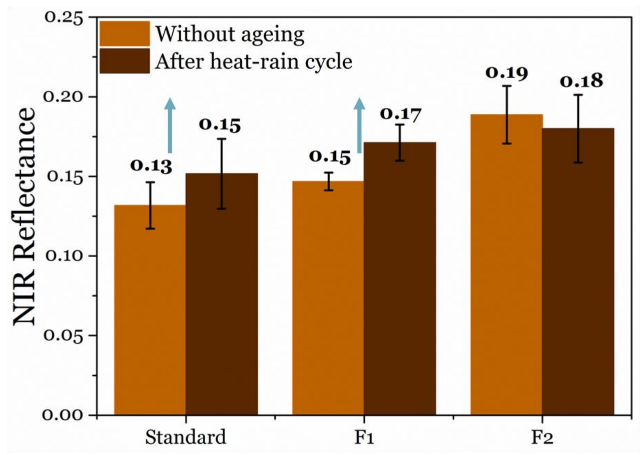
RESULTS AND DISCUSSION

Degradation reaches the insulation board which can result in **loss of thermal performance** due to material deterioration.

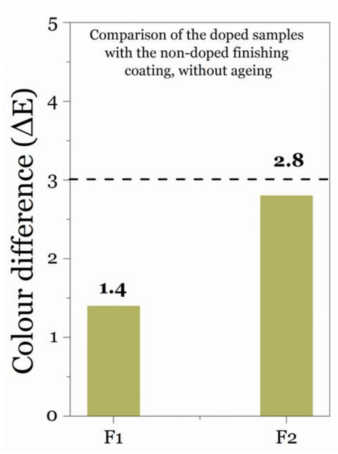


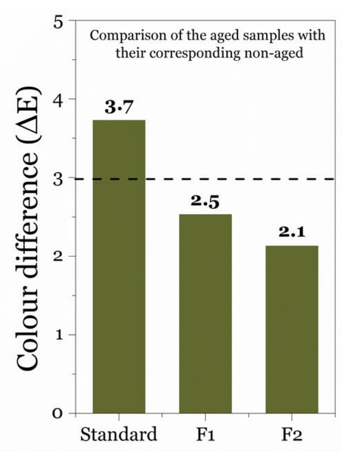
- **Optical properties assessment**

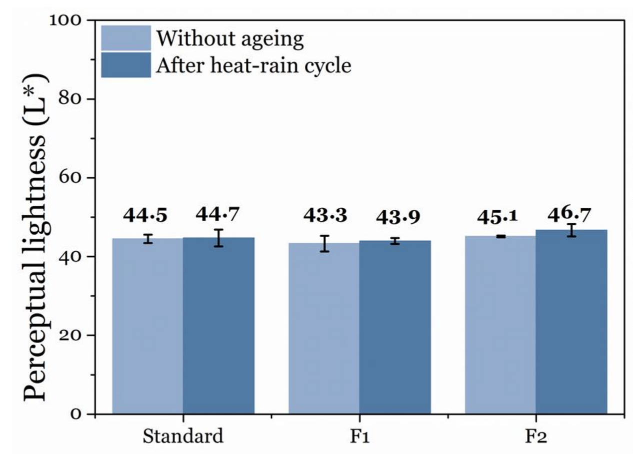




Inclusion of nanoparticles leads to **reflectance improvement**







1.5< ΔE < 3 perceptible is widely accepted in the literature as **colour matched [7].**

- The inclusion of these nanoparticles did not excessively change the color of the commercial finishing coating since the color difference is below 3;
- The doped samples preserve the visual aesthetic when compared to their correspondent non-aged samples.

CONCLUSION

- The incorporation of these nanoparticle improves the optical properties when compared to the non-doped specimen;
- One can observe an overall total reflectance increase for the two doped samples (15% and 20%) when compared to only 12% of the non-doped finishing coating, providing a similar visual aesthetic (ΔE less than 3);
- After the heat-rain cycles, the doped samples maintain the visual aesthetic when compared to the samples without ageing.
- Less bio-susceptibility and surface degradation is found for the doped samples.

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ACKNOWLEDGEMENTS

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