Envelope systems with high solar reflectance by inclusion of nanoparticles – an overview of EnReflect Project

Nuno M. M. Ramos[1*], Joana Maia[1], Rita Carvalho Veloso[1, 2], Andrea Souza[1], Catarina Dias[2], and João Ventura[2]

[1] *CONSTRUCT-LFC-Departamento de Engenharia Civil, Faculdade de Engenharia, Universidade do Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal*

*Corresponding author: nmmr@fe.up.pt

[2] *IFIMUP –Departamento de Física e Astronomia, Faculdade de Ciências, Universidade do Porto, Rua do Campo Alegre s/n, 4169–007 Porto, Portugal*

Abstract. Increasing building energy efficiency is crucial for transforming the EU energy framework. The use of thermal insulation materials is an effective way of reducing heat losses in buildings by increasing the thermal transmittance through the building envelope. In addition, new eco-efficient materials and technologies are being developed to mitigate building cooling needs. One of those technologies uses high reflective (HR) materials with high solar reflectance and infrared emittance. HR materials constitute an attractive idea to reduce cooling loads, which is crucial for attaining the Nearly Zero Energy Buildings goal. Another benefit of this strategy is to broaden the range of colours of the urban aesthetic request to the dark ones, overtaking the current white-cool solutions.

Therefore, the project's main goal was to re-design envelope systems by increasing their solar reflectance through nanotechnology., The main idea was to fabricate novel nanomaterials with high near-infrared (NIR) reflectance by tuning their optical properties. As such, this project focused on the synthesis of nanoparticles with improved NIR reflectance, the evaluation of the hygrothermal-mechanical behaviour, the characterization of the more relevant material properties and the durability assessment.

One of the main achievements was the development of a facile synthesis of a nanocomposite with improved performance in the NIR region that allowed the reflectance improvement of a dark finishing coating. The development of a Multiple Linear Regression model allowed estimating the maximum surface temperature for Mediterranean climates under different optical parameters, closely approaching complex numerical simulations. This contributes to quickly assessing the hygrothermal risk of these coatings in extreme climatic conditions. The study of the hygrothermal-mechanical behaviour of thermal enhanced façades led to the development of a new durability assessment methodology which contributed to closing a standardization gap. The produced nanocomposite increased the optical performance of a black finishing coating compared to the conventional black one without excessively influencing the original colour. Also, the incorporation of such nanoparticles had a positive effect on keeping their optical properties after accelerated ageing cycles. The referred optical properties were performed using a modular spectrophotometer enabling in-situ tests after natural ageing. The incorporation of HR pigments contributed to maintaining the colour characteristics even in dark coatings. The main contribution of these pigments is the solar reflectance increase and, consequently, the decrease of surface temperature, especially for high outdoor temperatures.

Keywords: Envelope, High reflective nanomaterials, Thermal enhanced façades, Durability.