

NANORENDER - Performance of silica nanoaerogel-based renders

Executive Summary (in English)

The aim of this project is to investigate the use of silica-based aerogels in coating mortars (renders) in order to formulate improved-performance renders from a thermal, acoustic and environmental point of view, for application in building walls.

In the last years the construction industry has undergone profound changes triggered by the growing concerns with sustainability, coupled with more demanding energy and environmentally wise European directives (Directives 2002/91/CE from 16 December, and 2010/31/UE from 19 May). On the other hand Portuguese legislation in terms of energy performance of buildings (Decree-Laws No. 78/2006, 79/2006 and 80/2006) has encouraged the search for new products and construction systems with a better hygrothermal performance. In this context, the development of new coating solutions has significantly increased recently, aiming at reducing the incorporation of processed raw materials and energy and the environmental impact from the production, use and final destination of the product at the end of its service life.

The renders market (the most used external covering solution in Portugal, with around 62% of all types, from a universe of 3160043 buildings) has increasingly responded to the integration of more sustainable strategies. The use of ready-mixed mortars, with controlled compositions of aggregates, admixtures and additions, has been improving the in-service performance of these products, minimizing degradation phenomena (due mostly to water entry). Recent studies on thermal and acoustic insulation mortars most often at the research level yet aim to contribute to a better global performance of walls in new and rehabilitated buildings, by minimizing energy consumptions within an environmental and economic strategy.

Nanotechnology in the construction industry has allowed acting at the microstructural level of conventional materials, improving their physical and chemical properties. Aerogels come into this equation as very porous mineral materials composed mostly of air that can be produced as powder or grain-shaped leading to significant improvements of the products they incorporate. As a matter of fact the potential of aerogels is consensual in the scientific/technical medium because they are extremely light (density below 500 kg/m³) and have a high thermal (thermal conductivity down to 0.01 W/m.K) and acoustic (acoustic impedance below 106 kg/m².s) performance. Their large-scale use in construction, namely in the thermal and acoustic insulation area, is presently possible since the high costs associated with their production have been overcome.

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In this project, named NANORENDER, the goal is to use as aggregate in mortars a silica or silica/latex-based aerogel, obtained from safer and less costly processes, already tested and patented by members of the research team. This change may lead to economically competitive mortars, with improved hygrothermal, mechanical, physical-chemical and environmental performance, a thickness closer to that of current mortars even though compatible with the growing sustainability demands in construction, and simultaneously complying with the requisites of European norm EN 998-1 that is the basis of CE marking of coating mortar products.

Therefore, the composition and size grading of the aerogels to be used will be optimized and various aerogel-based mortar mixes will be studied, with various changing parameters such as the aggregates content, the water/binder ratio, and the admixtures and additions content, in order to analyze the performance properties in mortar specimens. To evaluate the behaviour of renders various characterization tests of the performance of mortars applied in brick models and later on in prototype wall panels will be made, using different values of the mortar's thickness. Finally, the project comprises a theoretical simulation to predict the performance of renders applied on building walls, with different backgrounds and in in-service conditions, in order to characterize and quantify the economic, environmental, thermal and acoustic benefits that nanoaerogel-based renders can bring to the construction industry vis-à-vis conventional renders.

The main objective of this project is thus to study competitive alternatives in the national and international markets that use advanced technology (nanotechnology-related) and can significantly improve the performance of conventional renders (traditional or ready-mixed), cement-based and more compact/resistant, that are currently applied in building walls.