First approach to thermochromic mortars: compatibility between thermochromic pigments and cement

G. Perez*[†], A. Guerrero[†] and A. Pons[#]

[†] Institute of Construction Science Eduardo Torroja (IETcc)
Spanish National Research Council – CSIC
Serrano Galvache 4, 28033 Madrid, Spain
E-mail: gperezaq@ietcc.csic.es, aguerrero@ietcc.csic.es

[#] Institute of Optics (IO)
Spanish National Research Council – CSIC
Serrano 144, 28006 Madrid, Spain
Email: alicia.pons@csic.es

ABSTRACT

Construction materials with reversible thermochromic behaviour are of significant interest to improve energetic efficiency in buildings and to reduce the environmental problem of the heat island effect associated to urban development.

Thermochromic materials are characterized by a change of their colour for a critical temperature value (T_c). These materials are especially interesting for building envelopes when the change is from a light colour at temperatures beyond T_c, to a dark colour at temperatures below T_c. With this behaviour it is expected that the solar reflectance would be high when the ambient temperature is high, thus reducing over-heating of the building during summer. On the contrary, when the weather is cold, the material would show a low solar reflectance and absorption of solar radiation would help warming the building in winter. Consequently, using reversible thermochromic materials in the building envelope would help to meet the demand of a thermally comfortable indoor environment, with the subsequent improvement in energy efficiency, and also would reduce environmental impact of urban construction.

This type of solutions have already been considered for thermochromic coatings in cold roofs [1]. In order to apply the same strategy to facades, the development of a reversible thermochromic mortar would be necessary. As a first approach to this target, the compatibility between pigments and cement based materials must be addressed. Several reversible thermochromic commercial products have been considered in this work, both in powder form and in aqueous solution. Microencapsulated pigments have been studied to increase their resistance to the highly alkaline environment and to the mechanically demanding mixing and casting procedures usual in cement-based materials. Moreover, two different cements have been used: an ordinary white Portland cement and an eco-efficient belite cement synthesized from fly ashes through a hydrothermal process, which shows a light cream color [2].

Cement paste specimens have been prepared with the two cements and with different amounts of pigments. The integrity of the microcapsules upon preparation and hydration of the specimens has been analyzed through scanning electron microscopy, while the stability of the thermochromic behaviour of the pigments within the cement matrix has been analyzed through measurements of solar reflectance at different temperatures. The results assess the compatibility of certain commercial reversible thermochromic pigments with cement based materials. Moreover, some requeriments for the mixing and casting procedures of cement paste specimens have been identified that will be useful for the development of reversible thermochromic mortars.

REFERENCES

[1] T. Karlessi, M. Santamouris, K. Apostolakis, A. Synnefa, I. Livada, "Development and testing of thermochromic coatings for buildings and urban structures", *Solar Energy*, Vol. **83**, pp. 538–551 (2009).

[2] A. Guerrero, S. Goñi, A. Macias, "Durability of new fly ash-belite cement mortars in sulphated and choride medium", *Cem. Conc. Res.*, Vol. **30**, pp. 1231-1238 (2000).