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An optical setup for monitoring the gypsum hardening-time

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Abstract – Mold casting time is a critical constraint for gypsum plaster uses, specially for rendering works, such as sculptural and building ones, so that industries should supply some previsions of the available handling time before a complete hardening of the material. We develop an electronic instrumentation, employing an innovative optical principia, that is able to follow the hardening progress of the plaster which occurs due to the re-crystallization phenomena taking place in gypsum-water moistures [1]. Many different solute-to-solvent ratios in the paste were monitored in preliminary tests leading to reproducible time delays that ensure the reliability of the approach.

A SURPRISING BEHAVIOR IS REPORTED which is observed when an optically coupled photo-emitter-photo-detector pair is applied to measure the *transmittance* of an optical signal passed through a sampling amount of plaster, whose thickness was previously standardized. It was considered the time duration that goes from the moment the gypsum and water are mixed until the paste definitely hardens. No tendency of monotonic time-dependent behavior is detected, as it would be expected to occur in the common sense, but a much more intriguing dynamics is registered (Figure 1).

It is well known that water is incorporated to the crystal lattice progressively to recompose the di-hydrated calcium sulfate [1] along with the hardening process taking place. In the beginning, however, an ionic solution results from solvation of the dissociated salty particles, which possesses some charge-carriers concentration that depends on the amount of water used to disperse the gypsum powder. Such a presence of relatively mobile charged particles in the medium is expected to give rise to some optical absorption [2] due to possible interactions of heavy ions with photons of the travelling radiation. Indeed, after some characteristic time range that seems not to depend only on the ratio solute-to-solvent but also on the faster or slower material sample specificity, the transmittance of the optical signal suddenly increases, as long as the hardening process accelerates towards its end. Such a close coincidence in the time behavior is confirmed by means of a counter-proof sample which is subjected to a standard mechanical test that is processed simultaneously outwards the optical setup [3].

Early hypotheses relative to the presumable correlation on time detected between the hardening progress and the optical transmittance of the plaster layer are formulated to explain such a surprising test behavior.

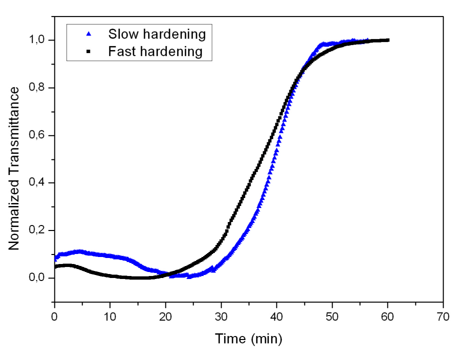

Figure 1: Normalized optical transmittance versus the hardening-time of the gypsum plaster. The curves exhibit similar shapes suggesting there is a standard behavior on time.

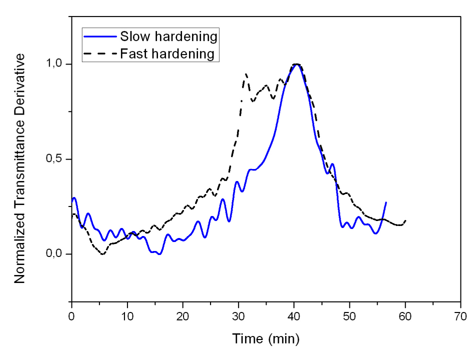

Figure 2: Normalized transmittance derivative versus hardening-time. The highest peak coincides with the sudden transmittance increase, which characterizes the end of the hardening time range.

[1] A J Lewry; J Williamson; *Journal of Material Science*, 29 (1994 a) 5279.
[2] J Singh, *Optoelectronics*, McGraw-Hill Series in Electrical and Computer Engineering, University of Michigan, 1996.
[3] K Song, J Mitchell, L F. Gladden; *Diffusion Fundamentals*, 10 (2009) 22.1.