Water Transport Monitoring in Calcium Carbonate Stones by Photoacoustic Spectroscopy

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Calcium carbonate is the most abundant inorganic material and has been used to build the ancient Mayan monuments as well as the colonial buildings in the Peninsula of Yucatán, México. One of the most important challenges that these structures have to confront is related to water and its transport inside the rock that induces serious deterioration [1]. In this work the photoacoustic (PA) technique is used to monitor the water permeability in such kind of stones. Photoacoustic spectroscopy is a highly sensitive technique that allows one to follow the dynamic behavior of complex systems by monitoring the thermal and optical properties evolution of the studied materials [2,3]. The analysis of water permeability in calcium carbonate stones is performed using a modified Rosencwaig photoacoustic cell. The flat sample is placed directly on the upper side of the photoacoustic cell very near to it. The opposite side of the sample is enclosed by a transparent window through which a modulated red laser beam is sent impinging on the bottom of the sample. In a first series of experiments a small water drop is applied on the external surface of the stone. The photoacoustic signal amplitude is observed to increase gradually, which is related to the wetting due to the water permeability. A second set of experiments were performed in which the water is mixed with methylene blue. In this case when the drop is applied, the photoacoustic signal amplitude shows a strong and gradual increase. Based on these two types of experiments the permeability of the stones is obtained as a function of the stone thickness for different kind of rocks and surface finishing.

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