THERMOGRAPHIC ANALYSIS AS AN NON DESTRUCTIVE TECHNIQUE FOR AN EARLY DETECTION OF BIOCOLONISATION ON BUILDING STONE

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Life on stones as microbial communities colonized substrates freshly exposed to the atmosphere where climatic conditions as sunlight, temperature and water availability are the key factors to the micro-organisms growth. The micro-organisms colonization is a widely recurring phenomenon which can lead to irreparable damage and the loss of unique cultural monuments. Besides the biological weathering, biofilms induce fouling that changes the visual aspect of monuments and statues. Biocolonisation is a major concern for conservators who face the endless maintenance of buildings which reach a notable economic costs.

Microbial communities composing biofilms spread thanks to nutritive elements found in the components of stone, and favour the anchorage of other micro-organisms such as fungi, algae, moss and lichen which deteriorate the materials by minerals dissolution and penetration of hyphae and roots driving to chemical and mechanical damage. In this respect, the early biofilm growth on stone walls must be taken into account to limit stones damage and financial costs. The colour measurement is currently used in cultural heritage as a non-destructive technique (NDT) to assess the biofilm spreading on a stone wall through its colour change. Nevertheless, other factors inducing colour variations are not driven by micro-organisms such as urban pollution, humidity degree and natural ageing of patina over time. Accordingly, the tracking of pioneer micro-organisms on stones is not always easy by this method and an earlier detection of biocolonisation should be more profitable than a visual one. In this study, infrared thermography (IRT) has been investigated in first assays in order to assess the sensitivity of this NDT to track down the biocolonisation earlier than colourimetry. It is an evaluation tool commonly used in monitoring and maintenance of buildings. The stone surfaces and subsurfaces are tested by analysis of thermal emissions. It is a powerful technique for art analysis thanks to its non-contact imaging application. This work analyzed thermal responses of biocolonised stones after a stimulation by a heating pulse (active IRT). Two natural limestones have been selected for their use in many buildings in Eastern France (Courville and Savonnières stones). Samples have been previously exposed six months in a garden where biofilms grew, then compared to non-exposed samples. The experiment has been set up in laboratory condition in order to avoid external artefacts. Recorded thermograms have been analysed by using post-processing calculations as SVD (Singular Value Decomposition) thanks to IR Explorer software and temperature variation of surfaces have been measured from them. First results displayed that SVD highlighted a net variation between stones without biofilm and stones with biofilm. Moreover, after a flash stimulation the maximum temperature was higher on the stone surface with biofilm than without it in dry and damp conditions for both types of stones. This study showed that active IRT could detect thermal variations on stones due to the biofilm settlement. This technique is thus able to highlight weak variations of energy for the detection of early biofilm.

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