



## Development of multi-action products for the sustainable conservation of porous stones from cultural heritage

CIVIL ENGINEERING PHD PROGRAMME

MADALENA RUCHA (madalena.rucha@tecnico.ulisboa.pt)

### Introduction

Cultural heritage in stone often includes varieties with high porosity and highly vulnerable to several damaging phenomena that need frequent conservation interventions. These interventions usually involve consolidation, protection and cleaning actions, however, each one of these actions have distinct risks to the safeguard of the object since new and accelerated degradation processes might arise. Especially in the most porous varieties of stones, there are limitations related to the technical performance and environmental sustainability of current products and conservation practices.



### Objectives

The main objective of this PhD thesis is to contribute to reduce the risk of conservation treatments in carbonate and silicate porous stones, using new and more compatible and sustainable solutions through the development and validation of multi-action products with various actions: consolidation and protection against water, graffiti and biological colonization. The target is to achieve a treatment with good performance on porous stones which implies adequate initial effectiveness, compatibility and durability.

### Preliminary Results

The development of the multi-action product started with the definition of the base formulation with consolidating action through the sol-gel process, using two types of catalysts (Figure 1).

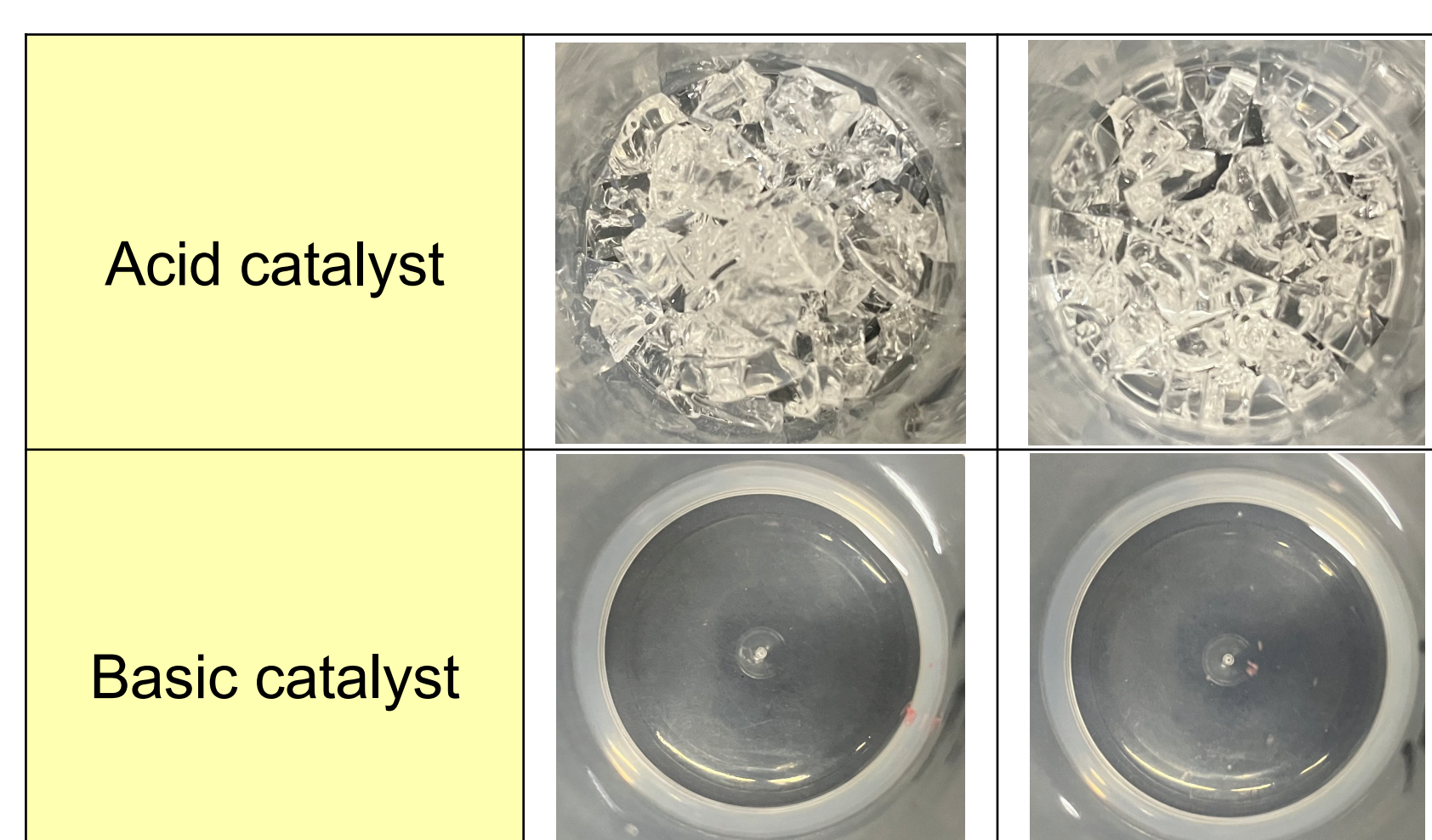


Figure 1: Formulations after drying (Xerogel).

Figure 1 shows xerogels with different features that depend on the type of catalyst used. The most promising formulations will be tuned to deliver hydrophobic/oleophobic properties (protective action) and a long-term biocide effect.

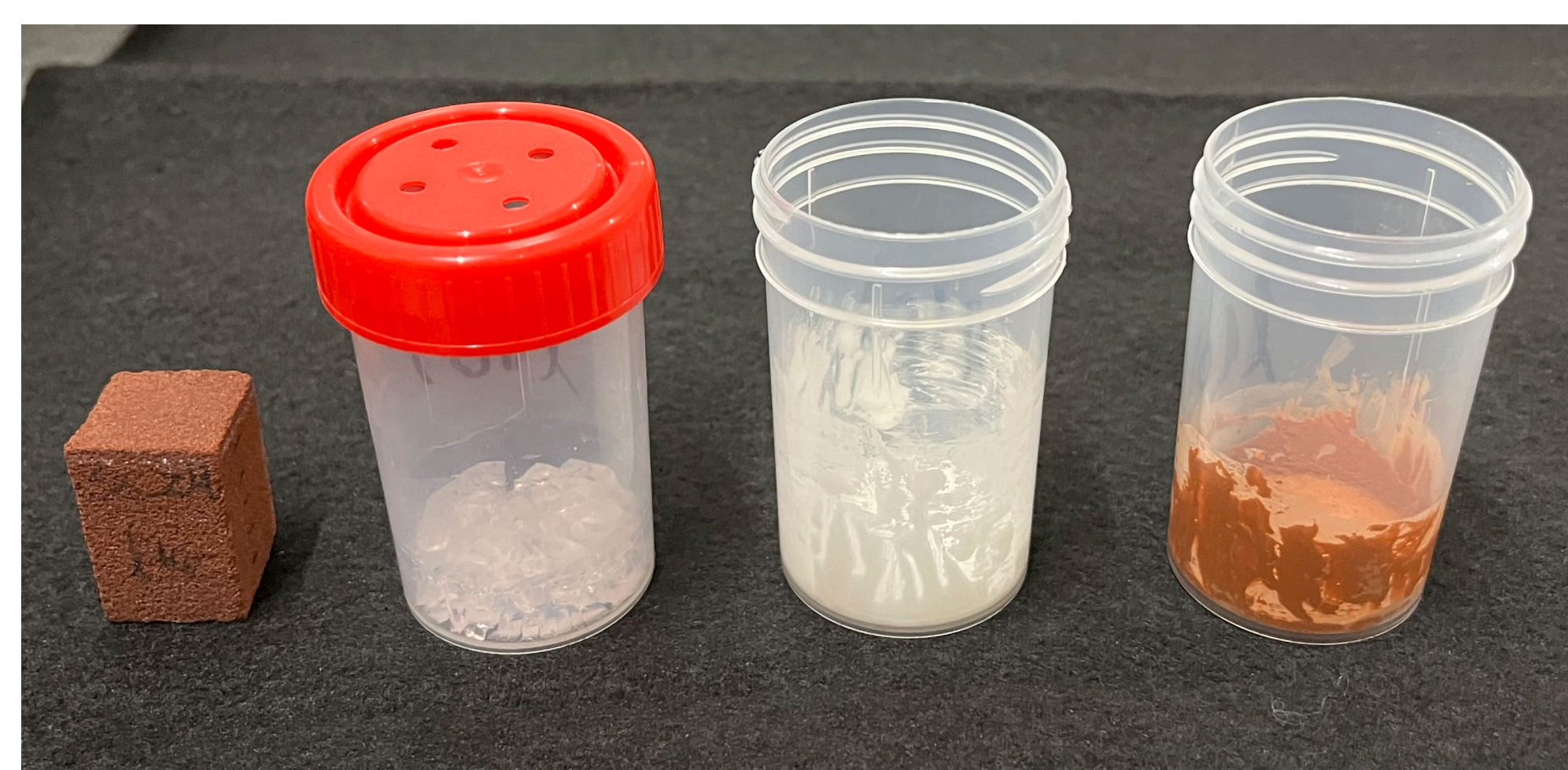


Figure 2: Preliminary evaluation.

A preliminary evaluation of systematically-developed formulations was carried out by assessing their viscosity, penetration capacity in porous stones, their drying rate in flask and when mixed with stone powder, Figure 2.

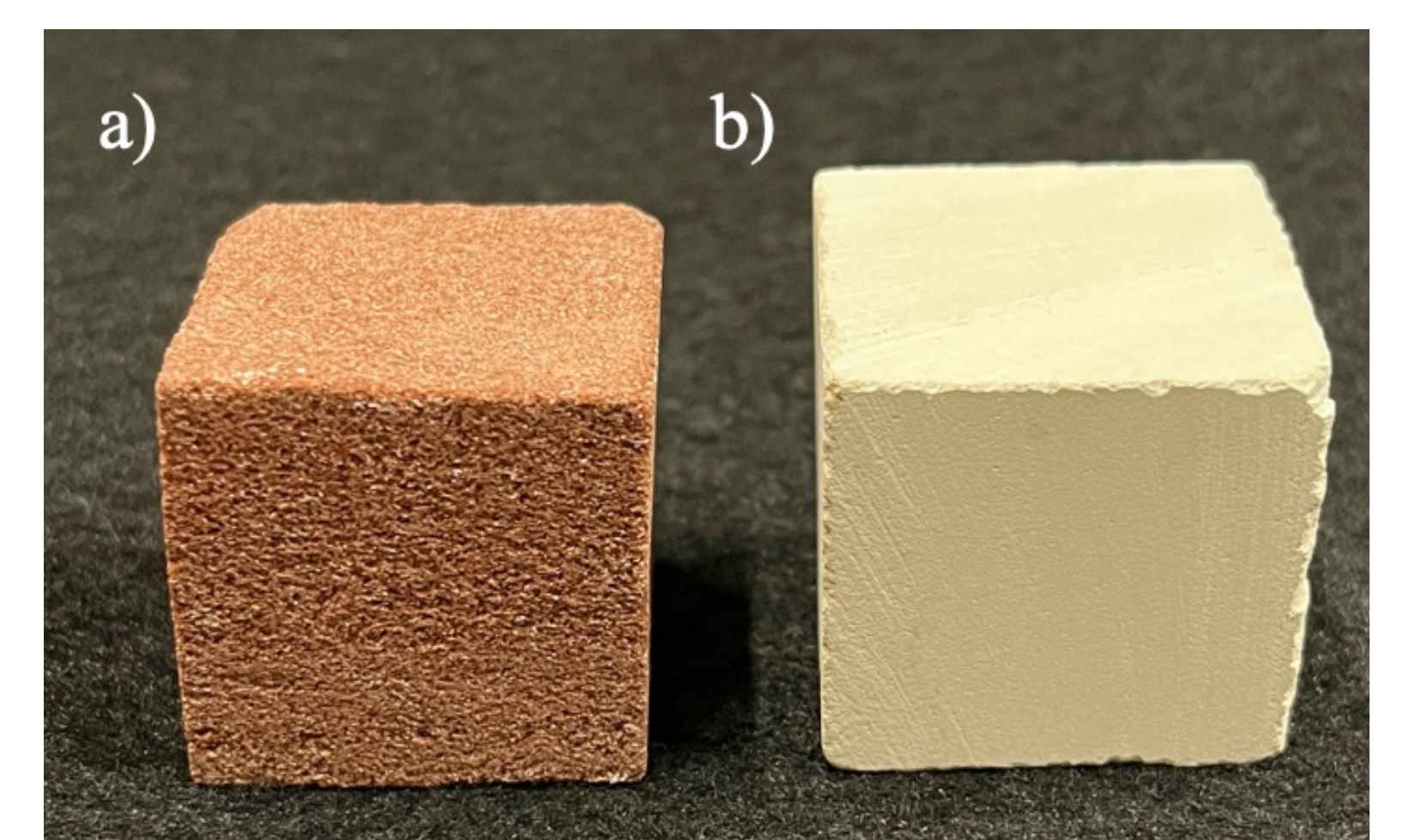


Figure 3: Silves Sandstone (a) and Pedra de Ançã (b).

After the preliminary evaluation, the formulations will be applied into stone samples of historic varieties (Figure 3) to evaluate their potential initial efficacy, compatibility and durability.

### Acknowledgment

Fundação para a Ciência e Tecnologia (FCT) for funding the Projeto GreenMAP - Green multi-action products for the sustainable conservation of historic porous building stones - (PTDC/ECI-EGC/2519/2020).