Innovative Developments in the Field of Stone Conservation by the Acrylic Resin Total Impregnation Process (AVT) of Natural Stones by the JBACH Company

by Gunthard Scholz, Robert Sobott and Wolf Ibach

Introduction  The complete saturation of valuable stone monuments and sculptures with MMA (methylmethacrylate) and the subsequent polymerization within the object is carried out by the JBACH company for 40 years. The process was proven especially for distinct sandstones, limestones and particularly for marble. More than 20.000 stone objects with a wide range of petrophysical parameters were conserved during this time period. Well-known examples are sculptures from the Cologne Cathedral, Sanssouci Palace in Potsdam or the Royal Palace of Huis ten Bosch in The Hague. The pore volume is practically filled with polymerized MMA after the process, apart from isolated vacuoles which are formed during the shrinkage of polymethylmethacrylate (PMMA). As a consequence, the water uptake is impeded and the stone texture is stabilized in a more homogeneous manner. Therefore a further weathering of the treated objects reduced significantly. A great advantage of the AVT process is the conservation of stone monuments at their original site.

Aim  Stones with a large pore volume take up a considerable amount of MMA with the consequence of a distinct thermal impact on the stone due to the strongly exothermal polymerization reaction. Against this background R&D work was done in the JBACH company during the recent years with the goal to modify the AVT process in such a manner that the thermal stress is reduced and the pore surfaces are cladded with a protective layer instead of a complete pore filling with PMMA. The prevention of the water uptake and the increase of the strength properties was to be retained and a reduction of the thermal strain should be achieved.

![Figure 1 Petrographic thin section (left) and SEM photograph (right) of AVT total impregnated Udelfanger sandstone. Open pore space is colored blue in the thin section. The PMMA pore cladding is indicated by arrows.](image1)

![Figure 2 Thin section (left) and three SEM photographs (above) of AVT total impregnated marble. PMMA is deposited within the slit pores and adheres to the calcite crystals. The AVT 50.6 and AVT 50.8 lead to very similar results with no conspicuous differences on a microscopic scale.](image2)

Results and discussion  The innovative development is based on a decrease of the polymer content of the impregnation solvent. A principal improvement is a reduction of the polymerization temperature below 90°C. The optical microscopy reveals a lining of the pore walls with PMMA (Figure 1). In the case of marble we no longer observe a complete filling of the slit pores with PMMA containing small vacuoles but delicate cellular PMMA structures (Figure 2). The lower polymer content reduces the thermal strain for marble by around 30%. In the case of more porous sandstones, the thermal strain is reduced though less pronounced as is demonstrated in the case of Udelfanger sandstone. Table 1 shows that the PMMA pore filling leads to an increase of the bulk density and all investigated mechanical parameters as well as to a decrease of the porosity and a capillary water uptake practically to nil compared to the deteriorated reference stones. The results are no less than a great improvement of the already very successful and efficient acrylic resin total impregnation process and of great importance for the preservation of cultural heritage in the form of stone objects. The successful conservation must be completed by a professional installation of the object at its original site which avoids rigid emplacement and guarantees that possible thermal strain is compensated by expansion joints.

![Table 1 Petrophysical parameters of weathered and AVT total impregnated Carrara marble and Udelfanger sandstone](table1)

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