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Physical-chemical Characterization of Black Crusts Coming from Cagliari Town Hall,"Palazzo Bacaredda", Cagliari (Italy)

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Abstract

Cagliari Town Hall (1899) known as "Palazzo Bacaredda" has been studied and restored many times from its building. Subsequently, the finding of black crusts on the plaster layer suggested us to identify the cause of their formation and analyze their crystal structure and composition in order to propose some strategies for their removal during the incoming restoration intervention.

Introduction

The Cagliari Town Hall "Palazzo Bacaredda" (Fig.1) is located in via Roma in the central district of Stampace. It is the seat of the Council of the Cagliari city and it assumes an important historical and artistical role because of its history and because it is the symbol of the Italian "Renaissance" in Sardinia.

It was built in 1899 to the will of the king Umberto I together with queen Margherita of Savoia that participated at the ceremony for laying of the first brick.

The Building takes its name from mayor Ottone Bacaredda that licensed the start of work.

The main building material is calcareous stone and the artistic style is very heterogeneous: it combines the Catalan gothic style and within it, one can possibly appreciate the lower layers and the Liberty style that is evident on the façade, with a lot of decorative elements such as mosaics, marble statues and bronzes.

Fig. 1; The façade and south side of Cagliari Town Hall "Palazzo Bacaredda", Cagliari,

The building was subjected to many modifications and, in 1943, it was damaged by the bombing.

The project foresees a general restoration and, in this context, we will study the problems of black crusts that are damaging the carbonatic material and the filling plaster.

Black crusts are products of deterioration of the stone materials that are located in urban environments so being exposed to pollution. These cause changes and deteriorations in plaster/stone materials. The UNI 11182/2006 defines black crusts as "*modification of the surface layer of the stone material of variable thickness of lasting quality. The crust is distinguished from the underlying parts for morphology and often for the color. It can also spontaneously detach from the substrate that, in general, is pulverulent and or disrupted*"

The building requires a fast intervention because the crusts can grow in a short period of time and can worsen its conservation status. In fact, black crusts have a darker tone than the original material and can absorb more IR radiation so that the different thermal expansion provokes a pressure and, in turn, the breaking of the surrounding materials.

Some samples were taken from the filling plaster that joins the façade's stones and, after embedding in cold resin, they were analyzed by using an optical stereomicroscope (OSM) and a scanning electronic microscope (SEM). The 4 faces of a fragment of the same plaster, not embedded in resin, were analyzed by SEM coupled to an Energy Dispersive Spectrometry (EDS).

Materials & Methods

SEM Evo 60 EP (by Zeiss, Germany) equipped with an X-ray microprobe INCA (by Oxford instruments, Abingdon-on-Thames, UK), optical microscope Stemi SR (by Zeiss, Germany) equipped with camera ASRDA75 (by OMAX, USA) optical microscope M205A (by Leica, Germany).

Results

The images obtained by the optical microscope (see Fig.2) highlight the microstructure of the sample and the presence of black crusts on the layer exposed to the external environment. The SEM gives better images of the sample's microstructure and the EDS analyses allow to identify its elemental composition (see Tab.1). Data in Table 1 evidence that the main component of both the sample and the black layer is calcium carbonate and the low concentration of sulfur, that can be attributed to the presence of gypsum, let to state that the sulfation occurred at a very low extent. On such base, we can assume that the black crusts are the product of the re-crystallization of calcite, leached by acidic rain, which has incorporated black carbon particles (C), terrigenous silico alluminate (Si and Al) and also some iron particles. The contemporary presence of Titanium and Iron, when the last is present at enough high concentration, let to suppose that Iron is present as Ilmenite.

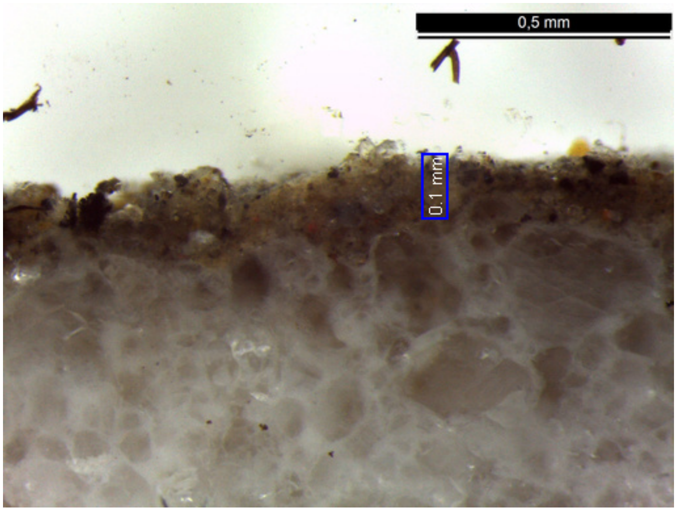

Fig. 2; Macro photo of a polished section of a plaster sample

Tab. 1; Semi-quantitative data from the SEM-EDS analyses of some zones of the plaster. Spectrum 2 is the only refereeing to the bulk, the others refer to the black crust

Spectra	C	Na	Mg	Al	Si	S	Cl	K	Ca	Ti	Fe	O
Spectr1	24.29			0.12	0.46	0.18	0.60	0.11	3.26	1.54	1.12	68.30
Spectr2	22.81				0.60		1.04		10.08			65.47
Spectr3	21.66	0.17	0.13	1.05	2.74		0.81	0.46	7.47		0.41	65.10
Spectr4	23.90			0.17	0.53	0.18	0.66	0.10	3.92	1.56	1.31	67.68

Conclusions

The SEM-EDS helped us to evidence the microscopic structure of the sample and to obtain the qualitative and semi-quantitive composition of both the bulk and the black crusts of the plaster samples. The analyses highlight the presence of carbonatic black crusts that penetrate in the plaster and, during the time, could get worse the conservation status of the plaster itself. On such base, we suggested a fast intervention to remove the black crust and, in respect of the historical and artistic values of the building, a mechanical cleaning by a fine grained sandpaper or atomized water or micro air abrasion. For the successive reintegration of the plaster, a $CaCO_3$ based dough must be used to maintain the original composition, in conformity with the theories of the conservation of historical buildings.

References

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