Protection of bronze statuary, comparison of classical treatments and approaches with carboxylates

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In outdoor environment bronze statues undergo degradations mainly caused by water (rain, moisture) but also related to air pollution (Robbiola *et al.*, 1993). These degradations lead to physical changes as a decrease in patina's thickness but also to aesthetic modifications of the work (Chiavari *et al.*, 2010). This patina, although due to the atmospheric corrosion of bronze, it's nevertheless an integral part of the statue since it gives the object its greenish color that is characteristic of works in bronze. To limit these changes environment/patina interactions should be reduced. Several treatments can be applied on the top of the statue: microcrystalline waxes (in our study we use only the Cosmolloïd® wax) or corrosion inhibitors (Kosec *et al.*, 2010). For the latter we've decided to work with carboxylates which are non-toxic and non-carcinogenic and whose use as corrosion inhibitors was developed for few years (Hollner *et al.*, 2010). Nowadays the efficiency of these treatments has not been consistently evaluated and we have little data about mechanisms that occur to microscopic scales within patinas, especially "old" patinas. This study aims to evaluate and compare the efficiency for both treatments by viewing their penetration in the patina layer and explaining the interactions to micro- and nanoscale between the treatment and the patina. First several patinas developed on various types of statues exposed in outdoor environment will be chemically and structurally characterized. In a second time both treatments will be studied. A graduated analytical methodology will be implemented on natural and artificial patinas. This methodology will combine traditional observation methods as scanning electron

microscopy and more specific approaches based on the use of µRaman and X-Ray diffraction. Otherwise, the use of isotopic tracers (^{13}C for the formulation of carboxylates, D_2O and ^{18}O) detected by TOF-SIMS before and after the corrosion putting back of the samples using a setting-up developed by the LAPA to reproduce the RH cycles will allows us to define the chemical and transport mechanisms for both treatments.

References

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