Silver and copper in Renaissance lustre pottery: nanoparticles, ions, and local environment

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Lustre pottery decorations are characterised by the presence of copper and silver nanoparticles dispersed in the more external layers of the glaze[1-3]. Following this finding, a study has been carried out on several original gold and red lustre samples, with the objective to better understand the lustre manufacturing technique and chromatic properties. Preliminary measurements were carried out by several techniques (XRF, SEM, TEM, Vis-NIR) [1], then EXAFS measurements were carried out at ESRF, on the BM8 beamline GILDA [2,3].

XRF and SEM-EDS measurements confirmed that gold and red lustre decorations are characterised by Ag and Cu. However, surface plasmon resonances in Vis absorption spectra indicated that, for gold lustre, metallic silver nanoparticles are mainly responsible of the colour while, in case of red lustre, responsible of colour are copper nanoparticles [1].

EXAFS measurements confirmed these observations. In most cases of gold and red lustre samples, copper and silver were found as metals, however, they have been also found in oxidised forms. Oxidised copper atoms were Cu^{+} and Cu^{2+}, with a large prevalence of Cu^{+} [2,3]. The observed simultaneous presence of metallic and ionised copper and silver are consistent with a lustre formation mechanism where the first step is an ion-exchange between copper and silver ions of the original lustre recipe, and the alkali ions present in the glaze (on average, total Na^{+} and K^{+}: 5-15% wt) [1-4].

Regarding the chromatic properties, only the fraction of reduced silver and copper are mainly responsible of the colour. This fraction can be low and variable case by case, depending on used recipes, reductive conditions and temperature of the kiln. It has been found that even the metallic Ag/Cu measured ratio cannot be in all cases simply and univocally correlated with the colour.

References

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