Luster decoration of ceramics: Mechanisms of luster development

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Luster is a ceramic decoration showing golden or coppery metallic shine and that can exhibit purple and blue iridescence. The origin of this decoration goes back to early Islamic times, *i.e.* the 10th century AD, and followed the expansion of the Arabian culture through Spain and the rest of the western Mediterranean. Transmission Electron Microscopy performed showed that in all cases examined the luster appeared to be a nanosized metal-glass composite (metal nanoparticles appear embodied in a glassy matrix). The metal particle sizes range between 5 nm and 50 nm and form a layer of thickness varying between 100 nm to 1 μm. A wide range of Cu to Ag ratio has been observed in the luster layers, ranging from pure silver to pure copper luster decorations, even in the same design. Their chemical composition is related to their color, yellow, green to brown for the silver rich lusters or orange, red to crimson for the copper rich lusters.

Luster is produced by direct application of a raw paint over a glazed ceramic which after firing in a reducing atmosphere results in the formation of the luster layer, the remaining paint (called cosela) is removed revealing the luster beneath. The composition of the lustre paint is therefore different from that of the final luster layer, and may vary widely. Typical recipes are a water (with some vinegar) suspension of a powder mixture containing about 50% of clay minerals mixed with iron oxides, copper or/and silver compounds and a sulfur containing compound. In particular, cinnabar (HgS) was found in the 13th century AD workshop from Paterna. Firing in reducing atmosphere is necessary to produce the transformation of the copper and silver compounds to metallic copper and silver. The question arising from these studies is how such nanostructures are formed. The mechanism should first the introduction of the copper and/or silver into the glassy matrix and then they must be reduced to achieve its metallic state. Moreover, chemical analysis of medieval luster showed a clear inverse correlation between the metal components of the luster decorations (Cu and Ag) and the presence of Na and K in the glaze. This result allows us to infer that a possible mechanism for the introduction of Cu and Ag into the glaze may be the ion exchange between the alkali ions originally present in the glaze and the metal cations present in the powder luster paint during the firing. However, the luster and glaze of these samples are quite weathered, and the loss of alkalis is very typical.
I will present the laboratory reproductions of luster following the original Paterna recipes which will give insight in the exact mechanisms involved in the luster development.