Nanoparticles structural identification reveal the manufacturing process of ancient ceramics

Inside a Roman Ceramic Factory in Ancient Gaul

Terra sigillata is certainly the most famous fine ware of the Roman period with characteristic decorations obtained by means of specially designed stamps (sigilla). This pottery was extensively produced in standardized shapes by a few specialized workshops and was widely distributed across the Roman Empire. Below is shown the diffusion map of one of these large workshops.

The success of this pottery was mainly because of the brightness and red color of the slip. Also in order to better understand the technical specificities of Terra sigillata, TEM and other characterization techniques have been used to investigate the microstructure and microcomposition of Roman period Terra Sigillata slips from various workshops.

A high proportion of spinel (≥25%) is characteristic of Italic productions (1st c. BC) while a high content of Fe-rich corundum(>30%) is the brand of south Gallic workshops (1st c. AC). This systematic difference is due to an evolution in the manufacturing process which permitted them to obtain a slip more resistant to the abrasion. ASTAR phase analysis indicates strongly that the ceramic sample provenance is from a factory at Graufesenque (South Gaule).

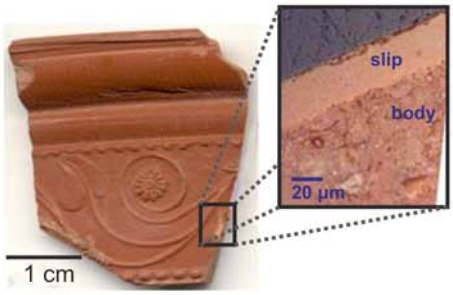


figure 1 Fragment of a decorated cup in Terra Sigillata

The challenge: Determine the nature, size and orientation of the different nanocrystallized phases of the slip

Solution: ASTAR technique coupled with precession electron diffraction

Experimental Data

TEM type: CM 20 FEG
Map resolution: 2 nm
Scanned area: 2 x 2 µm

figure 2

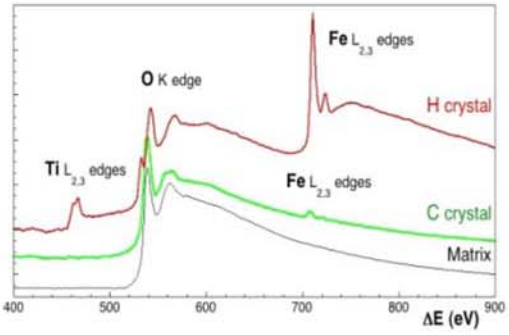
TOP: ASTAR high resolution phase (b) and orientation (c) maps for the crystals present in the slip of a Gallic Terra Sigillata from La Graufesenque workshop.
The slip coating consists of hematite (in red), corundum (in green) and spinel (in blue) crystals in a glass matrix (b).
In contrast with the coatings of other types of Greek and Roman potteries, there is no particular orientation of crystals.

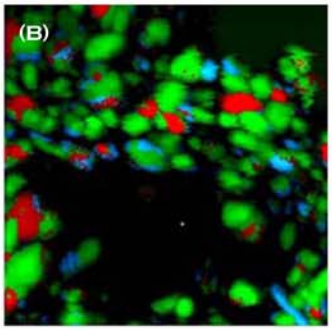
Courtesy S. Joulié, C. Roucau & Ph. Sciau, CEMES-CNRS Toulouse, France

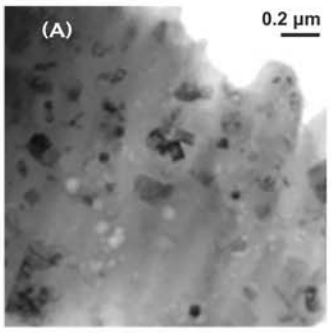
LEFT: EELS analysis of the matrix, hematite and corundum crystals .

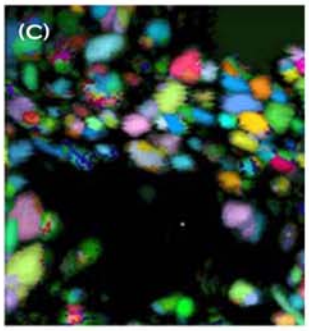
Crystal Structure

Spinel, $MgAl_2O_4$: Cubic, Fd3m
a= 8.09 Å
Corindon, Al_2O_3: Hexagonal, R3c
a=4.76 Å, c=13.0 Å
Hematite, Fe_2O_3: Hexagonal, R3c
a=5.03 Å, c=13.75 Å









Ph. Sciau et al *J. Am Cer Soc* 89 (2006) 1053, Y. Leon et al *JRS* 41 (2010) 1550