Cosmetic Recipes and Make-up Manufacturing in Ancient Egypt

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Powder x-ray diffraction, carried out at the ESRF (BM16), was used to elucidate the composition and the elaboration processes of the mineral constituents of ancient Egyptian cosmetics.

The funerary furniture discovered in Egyptian tombs, dating from between 2000 BC and 1200 BC, provides a lot of information about the customs of everyday life in Ancient Egypt [1]. Among these objects there was an abundance of toilet accessories: mirrors, hairpins, eyeliner applicators, combs or spatulas, and make-up receptacles, some of which are now preserved in the Egyptian Department of the Louvre Museum (Figure 1). Inside these 3-4000 year old containers made of marble, alabaster, wood or reed, were found cosmetic powders in an exceptionally good state of conservation. In order to decipher their composition and the methods used in their elaboration, the organic fractions were analyzed by chromatographic techniques and the mineral content by Scanning Electron Microscopy, IRTF spectrometry and powder x-ray diffraction [2]. Standard laboratory quantitative x-ray diffraction was impeded by several factors: 1) owing to the high archaeological value of the powders, only small quantities can be extracted and analyzed; 2) the as-found cosmetics are highly absorbing mixtures of lead-based compounds; 3) most mixtures contain as many as 10 phases, i.e. the resulting diffractograms display a complex series of overlapping Bragg lines. The measurements carried out at the ESRF (BM16) and at LURE (DW22) were able to take advantage of the high flux, the high energy and the high resolution. The Rietveld refinement method (Fullprof software package) was applied to work out the respective crystalline phase mass fractions. Taking into account the anisotropic line profile of some phases, it was possible to significantly improve the fit agreement factors (to less than 10%) and it was possible to detect quantities of minerals down to 0.5% (see Figure 2).

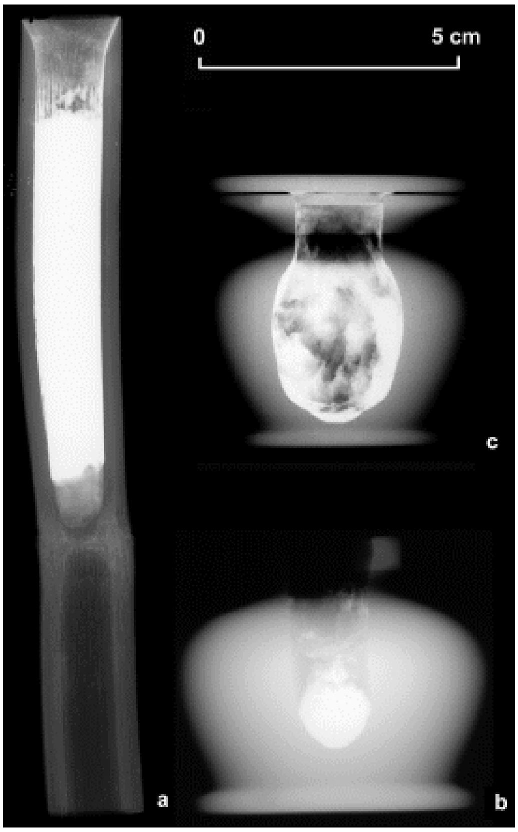

Fig. 1: X-ray radiography of different makeup receptacles from the Egyptian collections of the Louvre Museum. The white areas show the distribution of the X-ray absorbing lead powders present in the make-up. (a) reed case E, still full of makeup. (b) alabaster recipient with a fabric lid. (c) alabaster recipient and cover. It contains a small amount of makeup attached on the inner wall.

Two natural compounds bound with some animal grease were identified: crushed ore of black galena (PbS) and cerussite ($PbCO_3$). Galena is still the basic constituent of many khols traditionally used in North Africa, Asia and the Middle-East nowadays. White cerussite enters the composition of gray-to-white make-up. More surprisingly our analyses revealed the presence of two more white constituents: laurionite (PbOHCl) and phosgenite ($Pb_2Cl_2CO_3$). These products are very rare in nature and could not have been extracted from the mines in sufficient quantities for the preparation of the cosmetics. These products could have been formed by chemical alteration and ageing, assuming the original content of the make-up receptacles had been in contact with carbonated and chlorinated waters. However, no clear trace and no evidence of such alteration processes could be found in any of the 49 recipients.

Therefore one major conclusion of this work is that laurionite and phosgenite were intentionally manufactured by the Egyptians. The texts of Pliny the Elder and Dioscorides (first century AD) report on a number of medical recipes. In particular some of them refer to the use of lead oxide, that was ground and diluted into salted and sometimes carbonated (natron) water. This wet process was mimicked in the laboratory. By maintaining the solution at a neutral pH, a slow reaction yields white precipitates of either laurionite or phosgenite. This is the first indication that wet chemistry has been practiced since 2000 BC.

Why should these white lead derivatives PbOHCl and $Pb_2Cl_2CO_3$ be added to black PbS, since white cerussite $PbCO_3$ was sufficient to vary and tune the cosmetics tint from black to white? One should consider that since the earliest periods of Egyptian history, the cosmetics have been intensively used not only for aesthetic purposes, but also for their therapeutic and magic or religious properties. The Greco-Roman texts mention that the white precipitates synthesized from PbO are good for eye and skin care. These lead compounds could be used as a bactericide and as a protection for the eye against exposure to the sun's rays.

In addition, the diffraction peak profiles are also being analyzed, comparing strain and crystallite size broadening effects in archaeological, synthetic and natural powders [3]. Given the small instrumental broadening of BM16 (0.005° 2θ), a preliminary peak breadth analysis combined with SEM observations shows that the PbS ore present in the cosmetics was ground and sorted according to grain size. The resulting granulometry of galena provided the make-up with the expected texture and its metallic brightness. By contrast the Bragg line broadening of PbOHCl and $Pb_2Cl_2CO_3$ is free from any strain: this suggests that they have been directly synthesized as fine powders and have not been prepared by crushing. Therefore the x-ray line broadening related with the crystallographic microstructure can help to determine the origin and the process of elaboration of archaeological powders. ■

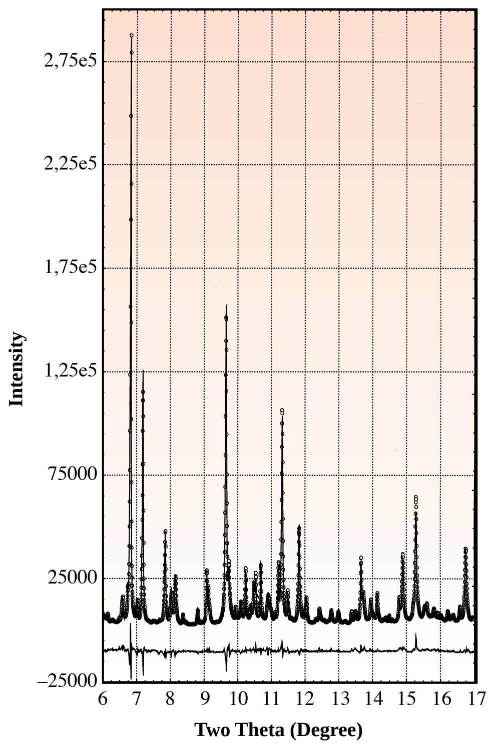

Fig. 2: Powder pattern measured on BM16 at λ = 0.35 Å of an archaeological sample dated from the Tutankhamon reign: observed (o), calculated (—) patterns and difference curve.

References

[1] *A. Lucas, J.R. Harris, "Ancient Egyptian materials and industries" (Edwards Arnold Ltd., London) (1963).*

[2] *Ph. Walter, P. Martinetto, G. Tsoucaris, R. Bréniaux, M.A. Lefebvre, G. Richard, J. Talabot, E. Dooryhee, "Manufacturing cosmetics in ancient Egypt", Nature 397, 483-484 (1999).*

[3] *P. Martinetto, M. Anne, E. Dooryhee, Ph. Walter, "Analysis of x-ray diffraction line profile of galena powders: a clue to some practices of mineral crushing in ancient Egypt", Proceedings of the 6th European Conference on Powder Diffraction (EPDIC6), Materials Science Forum (1998).*

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