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ID-7-P-3366 A study by Analytical Electron Microscopy of Metallic Artifacts from the Chichén-Itza Mexico.

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Chichen-Itzá one of the seven wonders of the world, is famous among other reasons because of its Sacred Cenote, a large flooded cavity formed in the calcareous ground typical of the Yucatan Peninsula, Mexico, mainly used for ritual acts. In the decade of 60's some metallic objects were extracted from the Cenote. In this work Electron Microscopy Analysis of the gilding pieces from the Sacred Cenote was performed in order to identify its constituent materials and possible manufacture process. The artifacts rich in copper and gold conserve its gilding even the damage due to burial and inadequate extraction and cleaning methods (Figure 1). The analyzed artifacts are soles of sandals and other pieces of the costumes dressed by the ones sacrificed in this. Scanning Electron Microscopy (SEM) and Energy Dispersive Spectroscopy (EDS) was used to study the surface of the samples, thickness, homogeneity, morphology and elemental chemical composition. The images were obtained with secondary and backscatter electrons (SE and BSE respectively). In figure 2 a SEM image shown an irregular surface with many roughnesses due to the corrosion occasioned by the environment in which the sample was exposed. The SEM images obtained with BSE show several contrasts that indicate an inhomogeneous chemical composition we can observe a film of high contrast mainly constituted by Au (zone 1) and other area with Cu (zone 2). It could be verified that the plating is a rich gold-silver alloy, the measurements pointed out to electrochemical deposition gilding instead of depletion gilding or other methods. Transmission Electron Microscopy (TEM) techniques were used in order to obtain information about crystals size and crystalline phases (figure 3).

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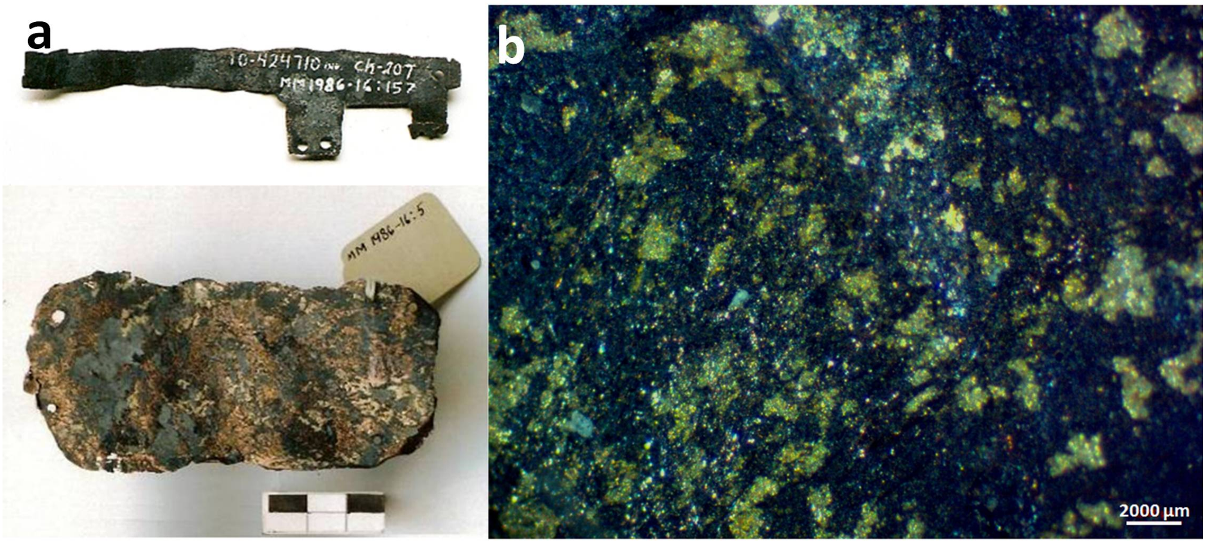
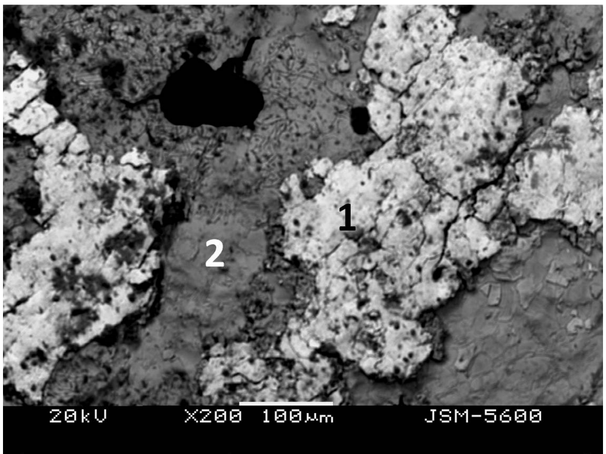


Fig. 1: a) Some of the studied gilded artifacts. b) Light microscopy image at 10X magnification, gilded areas are observed.



Element	Elemental concentration (% wt)	
	Region	
	1	2
O	14.89	12.32
Cu	27.69	67.75
Ag	5.91	3.18
Au	51.51	16.75

Fig. 2: SEM image of the stamped sheet to 500X, we can observe a rough surface with two regions of several contrast. In both regions, EDS analysis indicate different chemical composition, the area with high contrast (1) is rich in Au.

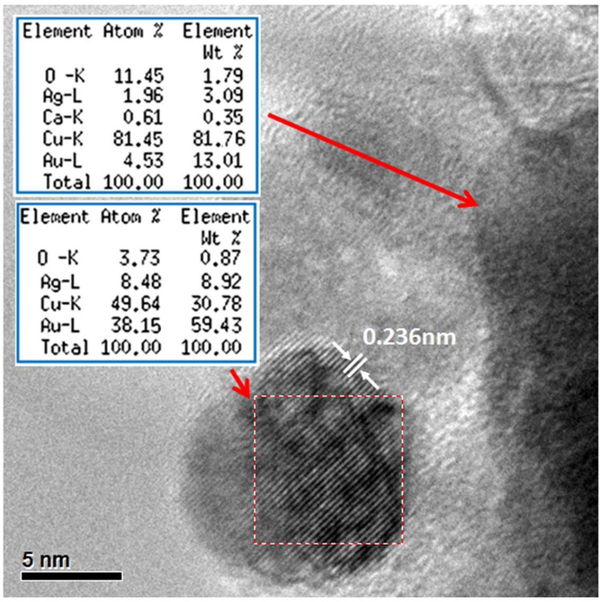


Fig. 3: Cuasi-spherical nanoparticle of size ~10 nm with Au as main constituent on matrix of Cupper oxide. Interplanar distance d = 0.236 nm is near to d111 = 0.2355 nm of Au.