

Unveiling ancient gold inlay technique of a bronze belt plaque

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Belt plaques were very popular in China originated from Eastern Zhou period (770 - 221 BCE). As personal ornament, they were thought to be worn by nobles or warriors that time to reflect their social status. The S-shape bronze belt plaque with gold inlay and cloud pattern studied in this project was from a private collection [1]. Similar plaques can only be found in the burials during the Warrior States (475 - 221 BCE) at Shaanxi region so far. As one of the early casting metals used in history, copper with its typical alloy tin, was a popular metal used in Central Plains of China well before the 16th century BCE [2]. Bronze belt plaques inlaid with elaborate patterns in gold were certainly fashionable luxury accessories at the period.

Non-destructive techniques including microscopic surface examination, x-radiography, energy dispersive spectrometry (EDS) and x-ray diffractometry (XRD) were applied to study the fabrication techniques of the belt plaque. The highly unique stylistic form of the belt plaque combined with the archaeological information in burial context and technical examination results by multi-analytical methods unveiled the ancient goldsmith technique of that region at the period that has rarely been studied before. Elemental analysis was carried out by EDS revealed that lead containing tin bronze alloy was used. It was a common metallurgical alloy to produce ornaments before the Iron Age. The trace elements it contained reflected the metallurgical techniques and origin of the ore sources. Tiny platinum group minerals inclusions were found on the gold surface containing osmium-ruthenium-iridium alloy provided an important clue for the provenance. Surface corrosions identified by XRD were closely related to the burial and storage environment.

From the x-radiographs, the wires and edges of the sheets of the gold inlay exhibited a bright halo which indicated the areas were thicker and thus revealed the deeper grooves were made along the wires and edges of the inlay sheet. This can be further supported by surface examination in the areas where the inlays were missing. Many parallel shallow tool marks were found on grooves under the inlaid sheets that served as a rough surface to strengthen the adhesion. Inlaying sequences can be discerned upon closer examination on the overlapping areas. Large sheets were made by joining separate pieces together and the wires were inlaid before the sheets. Surface finishing was so well executed that the joins could hardly be seen in most places. Polishing and burnishing marks in different directions indicated the gold decoration, both in wire and sheet form, was applied mechanically and the smooth surfaces were produced after extensive polishing. Stamping technique was used to create the curved pattern in relief as evidence by the repeating tool marks of the same size. Some grooves for inlay were cut before bending the bronze sheet to its final shape. No organic material had been found on the exposed grooves suggested no adhesives had been used, but the possibility of using clay for attachment cannot be fully excluded. It is interesting that there is a large amount of textile fibre in form of weaving textile pattern attached at the back side of the belt plaque which suggested it had been in contact with kinds of fabric in the burial environment. The fibres were identified to be hemp by microscopic examination.

Gold-inlaying technique was later fully replaced by the advent of the fire-gilding techniques. This study marks a start to the scientific study on the application technique of gold on tin bronze objects unearthed from the west of Central plains in China in the golden Bronze Age period.

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[2] Chen K., Rehren T., Mei J, Zhao C., *Special alloys from remote frontiers of the Shang Kingdom: scientific study of the HanZhong Bronzes from southwest Shaanxi, China*, Journal of Archaeological Science (2009)



Figure 1 Bronze belt plaque studied in the project

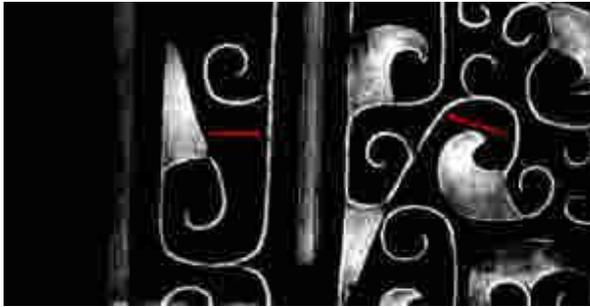


Figure 2 X-radiograph showing the twisting of inlaid gold wires



Figure 3 Grooves with parallel tool marks under inlaid sheets