# The Gilding of Armour

## MEDIEVAL AND RENAISSANCE TECHNIQUES

**A. R. Williams**
Leverhulme Unit for Ancient and Medieval Technology, UMIST, Manchester, England

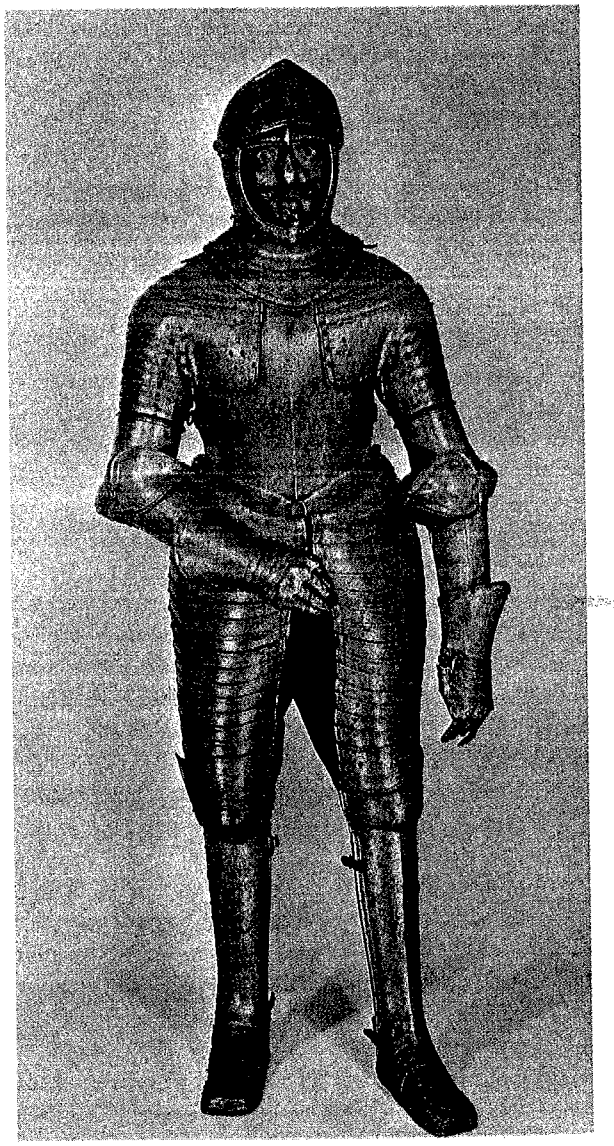
*Body armour during the middle ages and later was made of iron or steel plates, and for wealthy customers would be tailor-made and decorated by gilding. This article describes an investigation of the gilding methods employed.*

Few artefacts are so evocative of the Middle Ages of Europe as the suits of armour, that is body armour made up of articulated plates which remained the usual form of personal defence—for those who could afford it—from the beginning of the 15th to the middle of the 17th centuries.

The finest of these armours demanded metal-working skills of the highest order, for they were made to fit their owners, and frequently were decorated as well. Initially, such decoration consisted of fluting or other elaboration of shape, but from the close of the 15th century decorative patterns were etched on the surface and then gilded (1).

These patterns consisted at first of bands which, by the middle of the century, had enlarged into floral scrolls and other motifs, and which, by the close of the century, covered the whole of the armour with gilding, sometimes combined with blueing or russeting.

The gilding of non-ferrous metals is a very old decorative process. The recent work of Lins and Oddy (2) suggests that the gilding of copper or silver objects by methods involving hammering or soldering was known to the Mediterranean world by Minoan times (c. 1400 B.C.). Mercury gilding was probably employed during the later Roman Empire. It was described by Theophilus the Monk about A.D. 1100 in his technical treatise "De Diversis Artibus" (On diverse arts) (3). For iron objects, copper-plating is a necessary intermediate stage. This also is described in the anonymous 12th century compilation "Mappae Clavicula" (Little Key to Painting) (4). This was to be done by boiling with vinegar in a copper pot for an hour, and then standing the iron in



**A suit of armour made around the year 1645 for Charles, Prince of Wales, later to become King Charles II of England. Metallographic examination and electron probe micro-analysis show that the suit was made of wrought iron despite the high standing of its wearer, and that gilding was carried out by mercury gilding after a preliminary layer of copper had been applied**

**A section from the suit of armour made for Prince Charles. The only constituents visible are grains of ferrite and slag inclusions. The gold layer is unfortunately too thin to be visible** **×100**

the resultant dilute copper sulphate solution for some time. It was to be polished with an onyx stone and coated a second time if necessary before mercury gilding.

Such decoration would be applied only to fine armour, made to fit the individual customer. Munition armour, made in quantity for the ordinary foot soldier would be unlikely to be made of anything but wrought iron or mild steel, and generally fitted where it touched.

Much research remains to be done in this subject, but that carried out so far suggests that the best armour, which exemplified the most advanced technology of its day, was regularly made of steel by the end of the 15th century (5).

One example of a fine steel armour in the Tower of London Armouries is that made for Sir John Smythe in Augsburg about 1580 and decorated with bands of etching and gilding. Through the co-operation of Mr. H. Russell Robinson, Keeper of Armour, the writer was able to examine a plate from the short left tasset (thigh defence) which was made as an additional piece for exchange. Metallography shows a microstructure containing both tempered martensite and an irresolvable material which may well be pearlite. This is consistent with the reheating of a steel, whose carbon content varies, after it has been quenched. Since these operations have been combined with a gilding process as described above the procedure may well have been as follows:

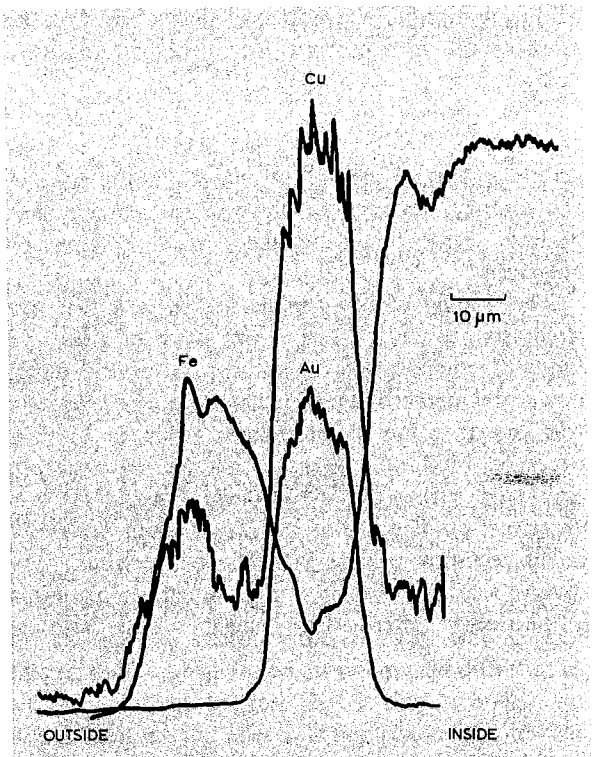
(a) The armour was fabricated from a steel whose carbon content varied between around 0.2 per cent and 0.5 per cent.

(b) It was quenched to harden it. The higher carbon areas of the steel have formed martensite. The lower carbon areas have formed other microconstituents, namely pearlite or bainite. It could have been etched before or after quenching.

(c) Gold amalgam has been applied where required, after coppering.

(d) A final reheating has volatilised the mercury and tempered the steel, resulting in a microstructure of tempered martensite and reheated bainite or pearlite.

To bond the gold without overtempering the steel in the absence of any instruments for measuring temperature must have required considerable skill. Evidently the empirical knowledge of the 16th century metallurgists was equal to this problem, for




**Electron probe micro analysis of gilded armour made for Prince Charles shows a layer of copper beneath the gold. The meter ranges used for the three elements illustrated were 10,000, 3,000 and 100 for the iron, gold and copper respectively. This corresponds to a copper composition of 1.75 per cent of the gold**

the surface hardness of the breastplate and helmet of this armour were measured in several places with a Branson Sonodur hardness tester and found to vary between 30 and 42 $R_c$, indicating that the sample studied was typical.

During the closing years of the 16th century the popularity of armour declined. The owner of the armour just descibed, Sir John Smythe, was a professional soldier who wrote a small book "Certain, Discourses . . . Concerning the Formes and Effects of Divers Sorts of Weapons", (6), which deplored this tendency, saying:

> "But that which is more strange, these our such new fantasied men of warre doe despise and scorne our auncient arming of ourselves both on horseback and on foote saying that we armed ourselves in times past with too much armour or peeces of yron"

However, it should be borne in mind that his armour would have been far better, possessing perhaps four times the hardness and tensile strength of most munition armour, than that issued to the soldiers he criticises.

Although armour remained in use through the Thirty Years' War (1618 to 1648) it was generally of inferior craftsmanship, and an example of such an armour is that made in France or England around 1645 for Charles, Prince of Wales, later King Charles II, and also decorated with gilding. A sample from a gauntlet was examined by metallography and proved to be made merely of wrought iron, despite the status of the customer. It was also possible to examine this specimen by electron microprobe analysis. A layer of copper was detected below the layer of gold, confirming the use of a method such as that described in the "Mappae Clavicula". The minimum detectable concentration of mercury on this instrument was 0.1 per cent, so the specimen was then subjected to emission spectrographic analysis. As a result of this, mercury was definitely detected in the spectrum.

**Acknowledgements**

This research has been supported by the Leverhulme Trust, to whom the author is indebted. He would also like to thank Mr. H. Russell Robinson, Keeper of Armour, and the staff of the Tower of London Armouries. Microprobe analysis was performed by Mr. B. Lambert of the Corrosion Protection Centre, UMIST, and spectrographic analysis by Mr. J. Bather of the Chemistry Department, UMIST.

**References**

1 J. Mann "The etched decoration of armour", *Proc. Bri. Acad.*, 1942, **28**, 17
2 P. A. Lins and W. A. Oddy, "The origins of mercury gilding", *J. Archaeol. Sci.*, 1975, **2**, 365
3 Theophilus "De Diversis Artibus" trans. C. R. Dodwell, Thomas Nelson, Oxford, 1961, 86–90
4 C. S. Smith and J. G. Hawthorne, "Mappae Clavicula; a little key to the world of medieval techniques", *Trans. Am. Phil. Soc.*, 1974, **64**, 4, 3 (recipe 245)
5 A. R. Williams, "Note on the Manufacture of Armour", *Metropolitan Museum Journal*, Vol. **13**, forthcoming
6 C. Blair, "European Armour", 1958, quoted on p. 143

GOLD, called also by chemists the Sun, Sol, and the king of metals, is a perfect metal, of a yellow splendid color, and unalterable by all the operations of art. This is the most perfect of all metals; its principles are the best combined, and it possesses most eminently the metallic characteristics. . . . The hardness of gold is intermediate betwixt that of the hard and of the soft metals. Its ductility is surprizingly great, and exceeds that of all metals.

Gold is unalterable by air and by water. It never contracts any rust; and when its surface loses its lustre, this is occasioned by the adhesion of extraneous matters, and not by any destruction of the metal. The action of fire does not occasion any alteration upon gold. No vapour or smoke rises from gold during its fusion; and it suffers no loss of weight by that operation, however long continued, or with the most violent fire. Gold resists also, while its aggregation is entire, the action of the strongest simple chemical menstruums, either in the dry or in the humid way.

From the English edition,
translated by James Keir,
London, 1771

PIERRE-JOSEPH MACQUER
*Dictionnaire de Chimie*
Paris, 1766