Early Methods of Cladding Base Metals with Platinum

THE WORK OF CHABANEAU, STRAUSS AND STODART

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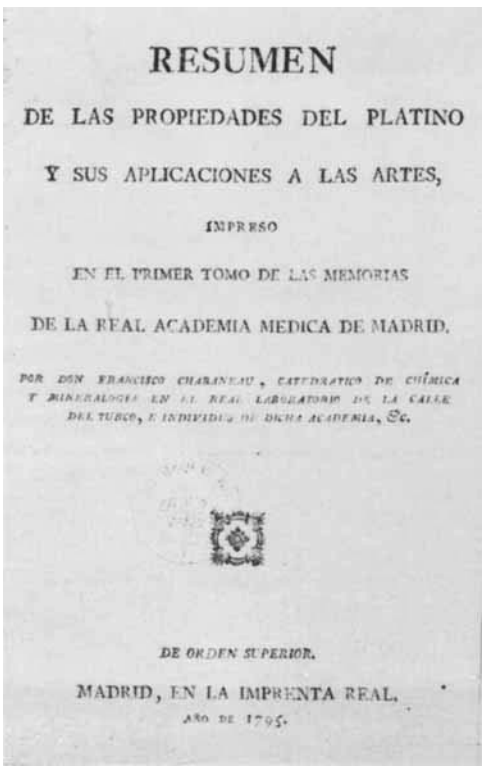
As has been shown by Donald McDonald, Pierre François Chabaneau was one of the first men to prepare malleable platinum, probably early in 1786, towards the end of his stay in the Spanish Basque town Vergara where he completed work initiated by Fausto de Elhuyar (1). He then moved to Madrid, where Charles III, whose government was trying to encourage the development of industry, created a chair of chemistry and mineralogy and provided a laboratory for him. It has not previously been noted that this move made Chabaneau eligible for election to the Royal Medical Academy, for the full members, as distinct from associates and correspondents, were required to live in the capital. Membership was limited to twenty physicians, five surgeons, five pharmacists and five non-medical scientists, and it was as one of the last five that Chabaneau became a member (2). The date of his election is not known, but it must have been before 1795, the year in which he published under the auspices of the Academy an account of the properties and applications of platinum (3) that is not included in the standard bibliography of the platinum metals (4).

Chabaneau said that he was unable to describe the methods used to obtain the malleable metal, which he called "*platino*" to distinguish it from the naturally occurring "*platina*", because a royal command issued at the beginning of 1787 had forbidden him to do so. This seems to confirm McDonald's conclusion that 1787 was the year when Chabaneau visited Paris, where Janety unsuccessfully tried to discover his method. The Spanish colonies in America were still



RESUMEN

DE LAS PROPIEDADES DEL PLATINO

Y SUS APLICACIONES A LAS ARTES,

IMPRESO

EN EL PRIMER TOMO DE LAS MEMORIAS

DE LA REAL ACADEMIA MEDICA DE MADRID.

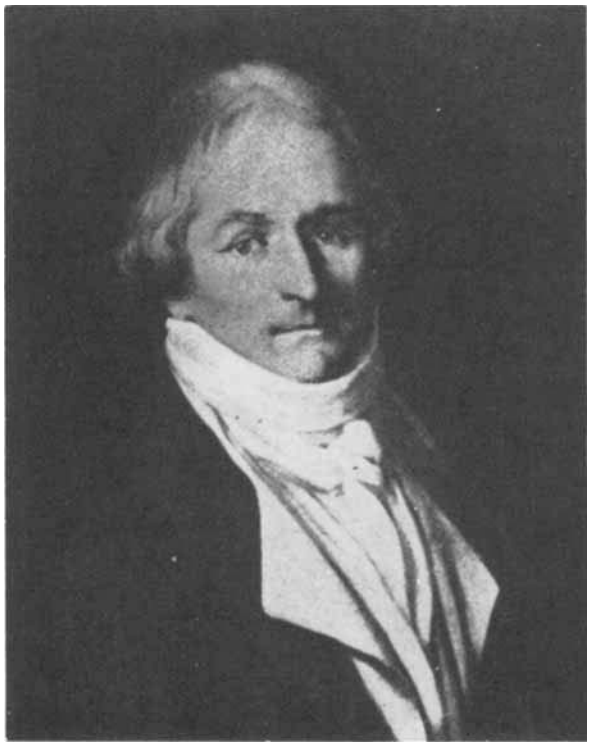
POR DON FRANCISCO CHABANEAU, CATEDRATICO DE CHÍMICA Y MINERALOGÍA EN EL REAL LABORATORIO DE LA CALLE DEL TURCO, E INDIVIDUO DE DICHA ACADEMIA, &c.

DE ORDEN SUPERIOR.

MADRID, EN LA IMPRENTA REAL.

AÑO DE 1795.

The title page of Chabaneau's eight page pamphlet on the properties and uses of platinum, which appeared in 1795, suggests that the memoir had already been printed in Memorias de la Real Academia Médica de Madrid ***although in fact it did not appear there until 1797. This copy of his very rare pamphlet is preserved in the Bibliothèque Nationale, Paris***



Pierre François Chabaneau
1754–1842

Professor of Chemistry at the Seminario at Vergara, Chabaneau was able to complete the work initiated by Fausto de Elhuyar and produce malleable platinum. He was probably the first person to develop a method of cladding copper with platinum

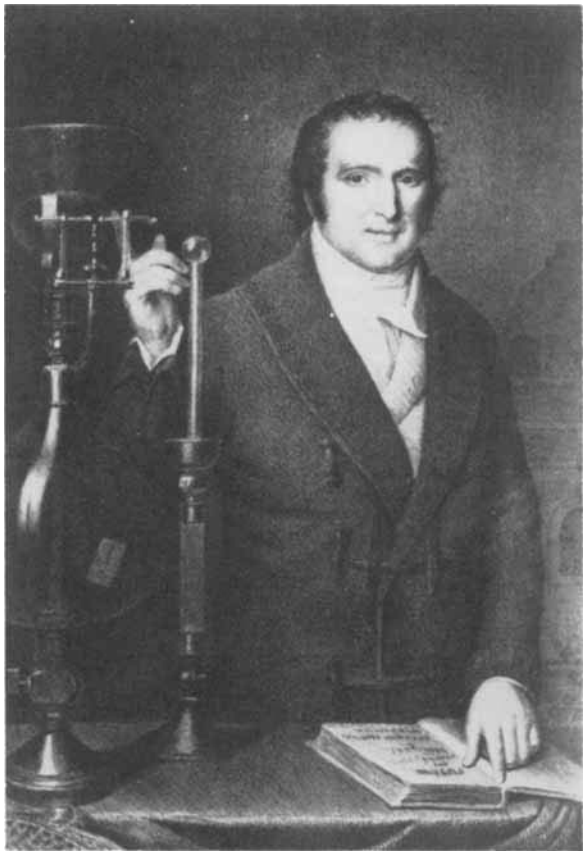
the only source of crude platinum, and the government was trying to develop a monopoly of the malleable metal. In his short memoir, Chabaneau therefore gave only an account of the principal properties of the metal, which were already well known, and drew attention to its actual and potential uses: some of these were novel and all were eventually realised. Its infusibility might make it a suitable thermometric substance for measuring high temperatures; its resistance to atmospheric corrosion might lead to its use in navigational and astronomical instruments and as a replacement for the gold point that made a lightning conductor more efficient; and it could also be used for striking commemorative medals.

An obvious application of platinum was in the manufacture of chemical apparatus, where its infusibility and resistance to attack by all reagents except aqua regia were of great value. Chabaneau pointed out that platinum crucibles already enabled minerals to be analysed with greater accuracy than before, and they might also be used for the manufacture of the flint glass needed for the best telescope lenses. He went so far as to suggest that platinum vessels of various shapes and sizes could almost entirely replace the immense assortment of glass, china, copper and cast-iron apparatus used in laboratories. The high density of the metal would make such apparatus heavy and it would be rather (*sic!*) expensive, but these difficulties could be overcome by using copper, plated with a thin sheet of platinum. This seems to be the first reference to platinum cladding in the scientific literature, and it was not a mere suggestion, for Chabaneau had found that platinum and copper united so intimately that the clad copper could be hammered into any shape without the metals separating. He added that it might also be made into vessels for use in the kitchen and in pharmacies.

Ending his memoir on a rhetorical note, Chabaneau expressed the hope that Europe would soon become aware of the useful properties of platinum and that Spain, its sole supplier, would greatly benefit. This was not to be. Even before Spain lost her colonies the platinum monopoly was broken, and in France and England methods of purifying and working the metal were soon

Antoine François de Fourcroy
1755–1809

A brilliant lecturer and writer, Fourcroy was one of the first chemists to adopt Lavoisier's antiphlogistic theory and became its most influential advocate. In this portrait by David he is pointing to a volume of his most famous work, Systême des Connaissances Chimiques *(1800). According to E. Pariset, writing in the* Mercure de France *in 1810, when Fourcroy died the titles of his principal works were inscribed on a platinum plaque attached to a platinum chain which was placed round his neck before his coffin was closed*



developed. In 1800 the French chemist A. F. de Fourcroy described its main applications and stated that the art of cladding iron and copper with platinum leaf was already established in Paris and that, when larger supplies of platinum were available it offered great potentialities for vessels to be used in the kitchen, in pharmacies and even in factories (5). Chabaneau had returned to his native France in 1799, but it is not known whether he introduced platinum cladding to Paris or whether it was developed there independently for Fourcroy mentioned no names. It seems, however, that the art did not flourish in France in the early years of the new century, for in 1806 the industrial chemist J. A. C. Chaptal made no reference to cladding when he was describing the uses of platinum (6).

When he returned to France Chabaneau brought samples of his work, and he presented a platinum-clad copper vessel to L. B. Guyton de Morveau who was, like Fourcroy, one of the leading French chemists, a member of the Institut and a professor at the École Polytechnique. Guyton had long been interested in the uses of platinum: as early as 1785 he made a platinum crucible (7) and in 1803 he invented and subsequently improved a platinum pyrometer (8).

Guyton's Survey of Platinum Cladding

In 1811 Guyton surveyed the various methods that had by then been used for platinum cladding, and he included a description of the vessel given to him by Chabaneau (9). It was in the form of a shallow bowl, 75 mm long, 52 mm wide, 14 mm deep and 0.78 mm thick at the rim. It weighed 34.505 grams. Its specific gravity was 11.44, and, as it contained only platinum and copper, with specific gravities of 21 and 8.87 respectively, he calculated that it contained 23.4 per cent of platinum and 76.6 per cent of copper by volume. (Guyton had, in fact,

L. B. Guyton de Morveau
1737–1816

Although remembered by scientists for his contribution to the modernisation of chemical nomenclature, Louis Bernard Guyton de Morveau had very wide interests which were not confined to chemistry. A classical education, a training in law and a literary reputation preceded his deep involvement in science which, however, was accompanied by his interest in both politics and education

miscalculated, for the correct answer is 21.2: 78.8.) Thus, he said, the platinum contributed just over a fifth of the total thickness, about the same as that of silver in silver-clad copper. (He was referring to silver leaf hammered on to heated copper in several layers and then burnished.) Gold as well as silver could be used in this type of cladding, called "*plaqué*", and it is clear from Guyton's account that this was the method used by Chabaneau for platinum.

Guyton pointed out that copper could also be coated with gold by covering it with gold amalgam and heating to drive off the mercury, or by dipping it into a solution of a gold compound (auric chloride) in ether. Both these methods were covered by the term "*dorure*" and he coined the word "*platinure*" for similar procedures that had been used for platinum. There was some doubt about the existence of platinum amalgam, but Guyton was convinced that in 1798 he had prepared it in a solid form by boiling platinum in mercury for two hours (10) and in his 1811 paper he referred to others who had apparently obtained it.

In 1797 Apollos Mussin-Puschkin added sal ammoniac to a solution of platinum in aqua regia, ignited the precipitate—ammonium chloroplatinate—and ground the platinum sponge so obtained with mercury in a mortar (11); he continued to work on these lines, using the amalgam for the preparation of malleable platinum by driving off the mercury by heat, until his death in the year 1805.

In a letter to N. L. Vauquelin, written in Madrid in 1803, J. L. Proust described how platinum sponge, formed in the same way, dissolved in hot mercury (12) and in a footnote added to the published letter Fourcroy and Vauquelin stated that platinum sponge would dissolve in cold mercury to form an amalgam (13).

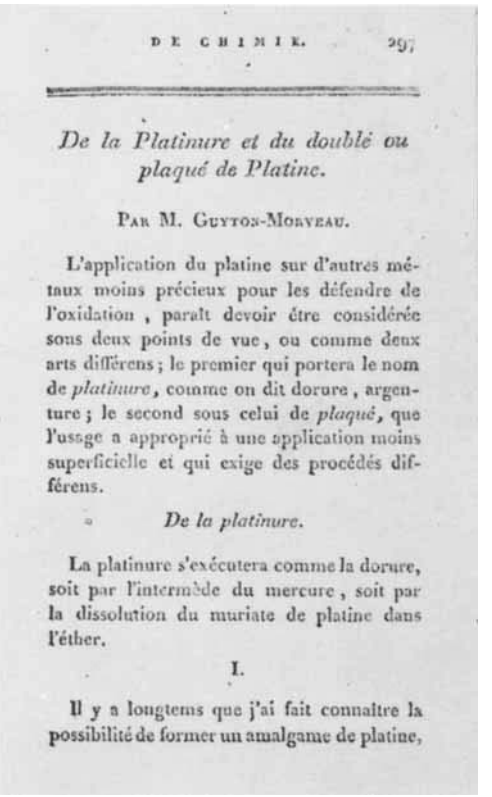
The Strauss Coating Method

Guyton recorded Proust's observation that the amalgam could be spread on copper and would make it possible for the copper to be coated with platinum, but it is not clear from Proust's letter whether he in fact succeeded. Coating by this method was, however, done in 1803 by a German called Strauss, who could not have known about

Proust's suggestion. All we know about Strauss is that he came from Asschaffenburg, a town on the River Main, and was working at Erfurt in the private pharmaceutical institute that was founded in 1796 by J. B. Trommsdorff (14) and was quite separate from the university, where Trommsdorff was a professor of chemistry. About three hundred students passed through Trommsdorff's Institute before his death in 1837; they received practical as well as theoretical instruction in chemistry, pharmacy and related subjects and aimed to become pharmacists, doctors, teachers or manufacturers (15). It was in a journal edited by Trommsdorff that Strauss described how he coated copper with amalgam (prepared in a way similar to Mussin-Puschkin's), heated it to drive off mercury, and then added another layer of amalgam mixed with a little chalk and moistened with water. A second heating left the copper with a coating of platinum that shone like silver when burnished and was, by virtue of its hardness and resistance to reagents, superior to the tin with which copper was commonly plated (16).

James Stodart of London

Guyton, in his 1811 paper, now drew attention to the work of James Stodart of London, who in 1805 used a solution of a platinum salt in ether. It was well known, said Guyton, that when a solution of gold in aqua regia was shaken with ether the gold compound—auric chloride—dissolved in the ether and the solution left a covering of gold when applied to another metal. In his important early account of platinum, William Lewis stated that a solution of platinum in aqua regia was unaffected by ether (17), but in 1805 Stodart found that in fact it behaved similarly to gold; the ether extracted a platinum salt—platinic chloride—and if polished iron, steel or brass was dipped into the ether solution it became coated with platinum (18). In collaboration with his friend "Mr Hume, chemist, Long-Acre", Stodart had already perfected a method for gilding iron and steel



DE CHIMIE. 297

De la Platinure et du doublé ou plaqué de Platine.

PAR M. GUYTON-MORVEAU.

L'application du platine sur d'autres métaux moins précieux pour les défendre de l'oxidation, paraît devoir être considérée sous deux points de vue, ou comme deux arts différens; le premier qui portera le nom de *platinure*, comme on dit dorure, argenture; le second sous celui de *plaqué*, que l'usage a approprié à une application moins superficielle et qui exige des procédés différens.

De la platinure.

La platinure s'exécutera comme la dorure, soit par l'intermède du mercure, soit par la dissolution du muriate de platine dans l'éther.

I.

Il y a longtems que j'ai fait connaître la possibilité de former un amalgame de platine,

In 1811 a survey of the various methods of platinum cladding was published by L. B. Guyton de Morveau in Annales de Chimie, *a journal which then devoted much space to applied chemistry. Guyton was one of the founders of* Annales *in 1789, and remained an active editor of it until his death in 1816*

in this way (19), and he thought that gold would generally be preferred as it was more beautiful than platinum. He added, however, that he achieved beautiful effects by coating different parts of the same instrument with gold and platinum. Stodart, a cutler, was probably referring to surgical instruments, which he made and sold at his shop at 401 Strand, opposite the Adelphi. The little that is known about Stodart's life has been published by Hadfield, who was unable to find a portrait (20). Stodart was interested in chemistry and metallurgy, and spent much time on attempts to improve steel. About 1818 he began to collaborate with the young Michael Faraday, preparing steel containing

This attractive trade card of James Stodart's, dating from about 1803, is preserved in the British Museum. Stodart, who became a Fellow of the Royal Society in 1820, also worked with Faraday on the preparation of steels containing the platinum metals

platinum and other noble metals, and this research led to his becoming a Fellow of the Royal Society in 1820, at the age of sixty. Faraday lost his enthusiasm for this work when Stodart died three years later.

Guyton's 1811 article contained no original observations, but his full summary of earlier work may have stimulated interest in platinum cladding, at least in France. In the same year the Society for the Encouragement of National Industry awarded a prize to Messrs. Levrat and Papinaud for their competence in producing gold- and silver-clad copper objects of high quality by the traditional method of hammering gold or silver leaf on heated copper. They also showed the Society a platinum-clad vessel, presumably made in the same way, that was stated to be "large and without any imperfection" and completely resistant to attack by the three mineral acids. Levrat and Papinaud employed thirty workmen, but their establishment at 66 Rue de Popincourt, in the working-class area of Paris not far from the site of the Bastille, had room for two hundred. They were therefore in a position not only to increase their production of gold and silver plate, but also to supply platinum-clad vessels to chemists and pharmacists (21). It is however, by no means certain that there was a real demand for such vessels, and it may be significant that at exhibitions organised by the Society in 1813 and 1814 they displayed only gold and silver plate, and no platinum (22).

The Society was, however, still interested in platinum cladding and in a report of the 1817 exhibition stated that the platinum prepared by Cuoq, Couturier and Bréant, whose work has been described by McDonald (23), could be beaten into very thin leaves. The reporter, Mérimée, suggested that it would produce very agreeable effects if used in conjunction with gold leaf; he said that silver and gold could not be used together because the silver rapidly blackened, but that platinum did not have this defect (24). It will be recalled that Stodart had earlier obtained such "agreeable effects" with gold and platinum applied by the ether process.

Although all the processes described so far had appeared in print, they were unknown to Thomas Thomson, professor of chemistry at Glasgow University, author of a well-known textbook and editor of the monthly *Annals of Philosophy*, in which he wrote in December 1819: "I am not aware that any process for covering metals with platinum has yet been published". Thomson was replying to an enquiry by T. Howse, senior, of Cirencester, who had heard from a chemical friend that some copper articles coated with platinum, in the proportion of fifteen to one,

could be purchased for about 37 shillings a pound from Monsieur Labouté, of 4 Rue St. Eustache, a street in the Montmartre district of Paris that has now disappeared. Howse did not know how the coating was done (25); his own attempts to use an amalgam had failed, but Thomson, in his reply, expressed the opinion that such a method should be possible (26).

In fact Labouté, who was also known as Michaud (27), did not use an amalgam. On 24 January 1818 he and a co-worker called Jean Dupuis were granted a patent for ten years for an elaborate process in which heated copper was first coated with silver leaf and platinum was then applied on top of the silver after burnishing, rolling and re-heating (28).

The letter Howse sent to Professor Thomson shows that Labouté's ware was put on sale, but there is no evidence of the scale of production and it is not known whether any other manufacturer took advantage of the expiry of the patent in 1828.

Platinum-clad vessels never seem to have been used in the kitchen, and chemists and manufacturers preferred apparatus made of solid platinum. Dr. C. Bromeis, of Hanau on the River Main, became interested in the use of platinum in jewellery, a local industry, and during the trade depression following the revolution of 1848 he described methods of mechanically coating copper and silver with platinum as an economy measure (29). However, it is unlikely that his proposals were adopted for by this time electrolytic methods had been introduced for both gilding and silvering and the relatively small demand for platinum plating was also satisfied by electrodeposition (30).

References

1 D. McDonald, "A History of Platinum", Johnson Matthey, London, 1960, 63–71

2 *Memorias de la Real Academia Médica de Madrid*, 1797, **1**, xxiii–xlii

3 P. F. Chabaneau, "Resumen de las Propiedades del Platino y sus Aplicaciones a las Artes", Imprenta Real, Madrid, 1795; reprinted in *Memorias de la Real Academia Médica de Madrid*, 1797, **1**, 183–188

4 J. L. Howe and H. C. Holtz, "Bibliography of the Metals of the Platinum Group, 1748–1917", U.S. Geological Survey Bulletin 694, Washington D.C., 1919

5 A. F. de Fourcroy, "Systême des Connaissances Chimiques", Baudouin, Paris, 8vo, 1800, VI, 437

6 J. A. C. Chaptal, "Chimie Appliquée aux Arts", Deterville, Paris, 1807, II, 281–282

7 W. A. Smeaton, *Platinum Metals Rev.*, 1966, **10**, (1), 24–28

8 J. A. Chaldecott, *Annals of Science*, 1972, **28**, 347–368

9 L. B. Guyton de Morveau, *Ann. Chim.*, 1811, 77, 297–304

10 L. B. Guyton de Morveau, *Ann. Chim.*, 1798, **25**, 3–20

11 A. von Mussin-Puschkin, *Chemische Annalen*, 1797, **i**, 195–202

12 J. L. Proust, *Ann. Chim.*, 1804, **49**, 177–187

13 A. F. de Fourcroy and N. L. Vauquelin, *Ann. Chim.*, 1804, **49**, 180–181

14 L. B. Guyton de Morveau, *Ann. Chim.*, 1797, **22**, 81–82

15 *Allgemeine deutsche Biographie* (Leipzig, 1894), XXXVIII, 041–644

16 Strauss, *Journal der Pharmacie*, 1803, **1**, (i), 18–24

17 W. Lewis, "Commercium Philosophico-Technicum", London, 1763, 611

18 J. Stodart, *Journal of Natural Philosophy, Chemistry and the Arts*, 1805, **11**, 282–284

19 J. Stodart, *Journal of Natural Philosophy, Chemistry and the Arts*, 1805, **11**, 215–216

20 R. A. Hadfield, "Faraday and his Metallurgical Researches", Chapman and Hall, London, 1931, 37–43

21 Bardel, *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, 1811, **10**, 227–229

22 *Bulletin de la Société d'Encouragement . . .*, 1813, **12**, 222 and 1814, **13**, 76

23 D. McDonald, *op. cit.*, 132–137

24 Mérimée, *Bulletin de la Société d'Encouragement . . .*, 1817, **16**, 34

25 T. Howse, *Annals of Philosophy*, 1819, **14**, 469

26 T. Thomson, *Annals of Philosophy*, 1819, **14**, 470

27 *Bulletin de la Société d'Encouragement . . .*, 1818, **17**, 394

28 M. Christian, "Description des Machines et Procédés Specifiés dans les Brevets d'Invention . . . dont la Durée est Expirée", Paris, 1828, XV, 216–217

29 C. Bromeis, *Polytechnisches Journal*, 1850, **116**, 283–289

30 R. H. Atkinson, "Electrodeposition of Platinum: Historical and General Review", *Journal of the Electrodepositors' Technical Society*, First International Conference, 1937, **13**, Paper No. 25