Techniques and Innovations

Purple of Cassius

Start with a recipe.

First, prepare something called *aqua regia*, a combination of aqua fortis and spirit of salt. The proportions can vary: Cassius himself says 2:1; William Peckitt recommended 3:2.[1] Use the aqua regia to dissolve some gold: a gold coin will be easiest to obtain. The dissolution will happen more quickly if the gold is shaved or cut into small pieces, and heat will speed the reaction. The solution will be yellow-colored. In a separate vessel, dissolve some tin filings in just enough aqua regia to make a solution. You need a large container for this, as the solution will effervesce and you might otherwise lose some of the liquid.

Fill a third container with clean water. Stir in first some drops of the gold solution and then about half as many drops of the tin solution. A red substance will precipitate out. Repeat these last two steps until all of both solutions are used up. Periodially collect the precipitate and wash it.[2] You may use separate containers for each collection, but not everyone suggests this.

The coloring material made by precipitating gold in a tin chloride solution is often called purple of Cassius, named after Andreas Cassius, who described it in his treatise *De auro* (1685).[3] It was known before then, however: it is mentioned by Johann Glauber and Andreas Libavius and the process to make it is described in a fourteenth-century Bolognese manuscript of painters' recipes.[4] This was not the only technique to obtain red colors from gold; eighteenth-century versions of Antonio Neri's *Arte vetraria* describes heating a gold powder until it turned purple and using this to create red-colored glass.[5] Purple of Cassius, however, had a noted advantage over other techniques; its color was stable in the presence of high temperatures. This made purple of Cassius an excellent coloring material for the vitreous colors: ceramics, glass, and enamels. And, as the basis for the Chinese *famille rose* porcelain colors that were fashionable in the seventeenth and eighteenth centuries, purple of Cassius is the unusual example of a coloring material adopted from the West into Asian manufactures.[6]

Gold. Der Goldpurpur, welcher eine Vermischung des fein zertheilten metallischen Goldes mit höchst entbrennstoffetem oder orngenirtem Zinnkalk ist, gibt dem Glasflusse eine Purpurfarbe, die durch den Zausatz von etwas Silber in das Rosenrothe übergehet. Er wird mit dem fein geriebenen Glasfluß nur gemischet; durch vermischung der dargestellten Porzellanmahlerfarbe mit verschiedenen Sorten Blau, werden mannichfaltige Schattirungen von Violet hervor gebracht. Das Knallgold ertheilt den Glasflüssen ebenfalls eine Purpurfarbe, die aber nach der Menge, worin es beygemischt ist, mehr oder weniger metallisch—goldglänzend ist, das heißt verhangirt. Ueberdem wird das ganz fein durch schwefelsaures Eisen (reaulinisch) gefällte Gold mit einemäußerst geringen Zusatz von Glasfluß zu regulinischen Goldfarbe gebarucht.

Johann Georg Krünitz, *"Gold," Ökonomisch-Technologische Encyklopädie* (Berlin, 1785), 19:419.

Ruby-colored glass based on this gold-tin solution is closely associated with Johannes Kunckel, glassmaker and alchemist to Elector Friedrich Wilhelm of Brandenburg. Kunckel had described experiments to calcine gold with aqua regia to make a transparent red color.[7] The affiliation of the best examples of this product with German and Bohemian glassmakers was exploited by Mayer Oppenheim when he applied for patents in Britain to make ruby and garnet colored glass.

I wish you would tell Mr Rhodes that the Calx Cassi he gave me for our use here is not the same as the last, we have try'd it in the same manner we treated the, but it is as dry as a brick, & a dirty brown color we cannot use it, & our Enamelers have nothing to do, & must play or do worse 'till he sends us some better color which I hope he will do by the first Coach. It is a sad thing that we cannot have two parcels of color alike. I suppose there is too little Gold, & too much Tin in this, & the salts not wash'd sufficiently out of it.

J. Wedgwood to T. Bentley dtd Etruria 24–26 Dec'r 1770 Wedgwood MS E18335-25.

Purple of Cassius is a powerful colorant as well as a beautiful one, and it will yield a range of purple, red, and pink colors that can be used in enameling and to decorate ceramics. The solution was so powerful that, despite the use of gold, it was not prohibitively expensive. One of Jean Hellot's correspondents noted that one *gros* of gold could make 49 *gros* of purple color when prepared for ceramic painting; if application is measured in numbers of brushstrokes, this could decorate a very large number of pieces.[8] Yet gold-tin reds were deceptively difficult to make. The technique required considerable skill, especially as the speed with which the components were combined controlled the resulting color.[9] Despite the ready availability of instructions in the procedures, it was a task for specialists.

Ce n'est que le phlogistique de l'étain conservé que l'on a trouvé, lorsqu'on a employé deux mesures d'esprit-de-vin à l place de deux mesures d'eau, contre une mesure d'eau régale, pour dissoudre l'étain; vu que l'esprit-de-vin est, comme on sait, très-chargé de … phlogistique, ce qui fait qu'il; conserve très-longtemps celui qui est dans l'étain.

C'est par cette raison que l'on fait de très-beau précipité pourpre, en mettant des feuilles d'étain telles qu'on les trouve dans des livrets chez les Doreurs, dans une bonne quantité de dissolution d'alun; si on filtre cette liqueur après que les feuilles d'étain y auront séjourné huit ou dix jours, & qu'on y mette ensuite de la dissolution d'or.

Didier-François d'Arclais de Montamy, *Traité des couleurs pour la peinture* (Paris, 1765), 111–112.

As a product of the chemical laboratory, purple of Cassius, like Prussian blue, inspired interest and continued exploration. Yellow obtained from silver may have been one complementary technique; instructions that call for a solution of silver in aqua fortis, also precipitated in water, appear in a number of manuscripts and were published in several eighteenth-century chemical and general treatises.[10]

Technique transfer between Purple of Cassius and other coloring materials is

equally obvious, if more circumstantial, in the development of Holland or Dutch scarlet; a red color for wool as bright and lively as the red of ruby glass. The technique, attributed to Cornelis Drebbel, used a tin mordant to brighten the color produced by cochineal.[11] The discovery, as reported in the eighteenth century, was a fortuitous accident similar to that of Prussian blue; fortunate in that the discovery happened to someone able to recognize and exploit it. Drebbel, it was said, accidentally broke a container of tin-infused aqua regia over a container of the cochineal extract used in making thermometers. This became, after subsequent experiment, a tin chloride mordant for the coloring material cochineal. (Tin had a long history of use as a mordant but not in this form.) The technique, once discovered and improved, became a standard for bright scarlet, supplanting the more traditional alum-mordanting process and ultimately replacing Venetian scarlet as the most desirable red color. At the time of his discovery Drebbel was employed by the prince of Wales; about 1627 a manufacture was established in London by Drebbel's son-in-law to produce what became known as "Bow-dye scarlet," a bright red wool. By the mid-eighteenth century, Karl Wilhelm Pörner noted that this tin solution was an indispensable ingredient of all scarlet dyes.[12]

The coloring material of purple of Cassius is a colloidal metallic solution; color is created by the reflection of light off metal particles that are, typically, about one-tenth the diameter of a wavelength of light. The precipitated gold is a red or red-purple color because gold reflects most strongly at the red end of the light spectrum.[13] This explanation for the coloring properties of gold in tin chloride was not possible in the eighteenth century, however. Efforts to understand the coloring principle of purple of Cassius, and attempts to use that understanding in the production of other colors, continued throughout the century. One explanation suggested that, in an analogy to the metallic oxides recognized as good colors for vitreous colormaking processes, gold oxide formed in the tin-aqua regia solution.[14] For John Wilson, the process to make purple of Cassius justified his understanding that objects reflect the colored rays of which there is the greatest abundance: When gold is dissolved in aqua regia, he noted, it reflects yellow in all directions. Complete the colormaking process: add some gold solution to water, and follow with a few drops of tin chloride. The solution will change from yellow to purple and the liquid will stain cloth purple. Nevertheless, Wilson did describe an unsuccessful experiment with direct dyeing of cochineal and a tin-aqua regia solution. And, when he attempted the transfer of this process to cotton goods, he found the result beautiful, but not permanent.[15] Elizabeth Fulhame, perhaps aware of Wilson's comments, tested this latter observation in her experiments on combustion and to find a way to adhere metals to cloth.[16] Purple of Cassius was, like Prussian blue, a manufactured color of nearly endless philosophical and practical possibilities.

Notes:

Note 1: Leslie B. Hunt, "The True Story of Purple of Cassius," *Gold Bulletin* 9 (1976): 138; William Peckitt, "To Dissolve and Prepare the Gold and Silver for the Rose, and Azure Colours" and "The Precipitate for the Rose Colour," in William Peckitt, *The Principals [sic] of Introduction into That Rare but Fine and Elegant Art of Painting and Staining of Glass*. (1793), York Museums Trust (York Art Gallery) York, England, Ms. f 9r–10v.

Note 2: These instructions are based on those found in Robert Dossie, *Handmaid to the Arts*, 2d ed. (London, 1764) 1:289–90; and Peter Shaw, "Experiment 5: The Way of Preparing a Metalline Colour, from Gold, and Tin, for Tinging Glass of a Beautiful Red" from Lecture XIV: Containing Attempts to Illustrate and Improve the Business of Colours, Dyes and Stains, *Chemical Lectures Publickly Read at London, in the Years 1731, and 1732, and Since at Scarborough, in 1733: For the Improvement of Arts, Trades, and Natural Philosophy* (London, [1734]), 184–89.

Note 3: Leslie B. Hunt, "The True Story of Purple of Cassius," *Gold Bulletin* 9 (1976): 134–39.

Note 4: William Lewis, "Tinging Glass and Enamel by Preparations of Gold" *Commercium Philosophico-Technicum; or, The Philosophical Commerce of Arts: Designed as an Attempt to Improve Arts, Trades, and Manufactures* (London, 1763), 170–81. On the Bolognese manuscript, see Mary P. Merrifield, *Medieval and Renaissance Treatises on the Arts of Painting* (1849; reprint., New York, 1967), 334.

Note 5: J. C. Orschall, *Sol sine veste*, in Antonio Neri et al., *Art de la verrerie, de Neri, Merret et Kunckel. Auquel on a ajouté Le sol sine veste d'Orschall; L'helioscopium videndi sine veste solem chymicum; Le sol non sine veste; Le chapitre XI du Flora Saturnizans de Henckel, sur la vitrification des végétaux; Un mémoire sur la maniere de faire le saffre*, trans. M. D. [Paul Dietrich, Baron d'Holbach] (Paris, 1752), 523–24.

Note 6: W. David Kingery and Pamela B. Vandiver, *Ceramic Masterpieces: Art, Structure, and Technology* (New York, 1986), 16–17, 318; W. David Kingery and Pamela B. Vandiver, "The Eighteenth-Century Change in Technology and Style from the Famille-Verte Palette to the Famille-Rose Palette," in *Technology and Style*, ed. W. David Kingery, Ceramics and Civilization (series), vol. 2. (Westerville, Ohio, 1986), 363–81.

Note 7: Johannes Kunckel, *Ars vitraria experimentalis Vitraria Experimentalis oder Vollkommene Glasmacher-Kunst* ed. Günther Stein (1689; reprint, Hildesheim, Germany, 1992), 151.

Note 8: [Jean Hellot], "Purpre de Cassius selon M. de Tournires," *Recueil de tous les procédés de la porcelaine de la Manufacture royale de Vincennes, décrits pour le roi: Sa majesté, s'en etant réservé le sécret, par arrest du 19 Aoust 1753*, [1753-4], BMNS, Y.51bis.

Note 9: Kingery and Vandiver, *Ceramic Masterpieces*, 42.

Note 10: Godfrey Smith, *The Laboratory, or School of Arts. . . The Laboratory, or, School of Arts: In Which Are Faithfully Exhibited and Fully Explain'd, I. A Variety of Curious and Valuable Experiments in Refining, Calcining, Melting, Assaying, Casting, Alaying, and Toughening of Gold; with Several Other Curiosities Relating to Gold and Silver; II. Choice Secrets for Jewellers in the Management of Gold; in Enamelling, and the Preparation of Enamel Colours, with the Art of Copying Precious Stones, of Preparing Colours forDoublets, of Colouring Foyles for Jewels, Together with Other Rare Secrets; III. Several Uncommon Experiments for Casting in Silver, Copper, Brass, Tin, Steel, and Other Metals; Likewise in Wax, Plaister Of Paris, Wood, Horn, &c., with the Management of the Respective Moulds; IV. The Art of Making Glass: Exhibiting Withal the Art of Painting an Making Impressions upon Glass, and of Laying Thereon Gold or Silver; Together with the Method of Preparing the Colours for Potters-Work or Delft-Ware.; V. A Collection of Very Valuable Secrets for the Use of Cutlers, Pewterers, Brasiers, Joiners, Turners, Japanners, Book-Binders, Distillers, Lapidaries, Limners, &C.; VI. A Dissertation on the Nature and Growth of Saltpeter; also, Several Other Choice and Uncommon Experiments; VII. The Art of Preparing Rockets, Crackers, Fire Globes, Stars, Sparks, &c., for Recreative Fire-Works; VIII. The Art and Management of Dyeing Silks, Worsteds, Cottons &c. in Various Colours,* 3d edition (London, 1750), 96; J. P. Buc'hoz, *Receuil de*

secrets, à l'usage des artists. (Paris, 1782), 1:222–23; "Procédés de Bailly," 15 Germinal an 5 [5 April 1797], BMNS C/1/8, pp. 3–4; "Acquisition du secret de Sieur Taunay pour les couleurs carmine, purpre et violet," n.d., BMNS C/1/14; [Hellot], "Carmine, purpre et violet" *Recueil de tous les procédés de la porcelaine de la Manufacture royale de Vincennes*, 122.

Note 11: J. G. Smith, "Cornelius Drebbel and English Scarlet Dyeing," *Ciba Review* 7 (1938): 231–36; Henri Adrien Naber, *De Ster van 1572: Cornelis Jacobsz. Drebbel 1572–1634* (Amsterdam, 1907).

Note 12: Karl Wilhelm Pörner, *Instruction sur l'art de la teinture: et particulièrement sur la teinture des laines* trans. C**** [Crottin]; ed. Desmarets and Berthollet (Paris, 1781), 6–7.

Note 13: Kurt Nassau, *The Physics and Chemistry of Color: The Fifteen Causes of Color* (New York, 1983); Kingery andVandiver, *Ceramic Masterpieces:*; John Carbert, "Gold-Based Enamel Colours: The Constitution and Applications of Purple of Cassius," *Gold Bulletin* 13 no. 4 (1980): 144–50.

Note 14: Carbert, "Gold-Based Enamel Colours," 146–47.

Note 15: John Wilson, *An Essay on Light and Colours, and What Colouring Matters are that Dye Cotton and Linen* (Manchester, 1786), 9 and 25–26.

Note 16: Mrs. [Elizabeth] Fulhame, *An Essay on Combustion with a View to a New Art of Dying and Painting Wherein the Phlogistic and Antiphlogistic Hypotheses are Proved Erroneous* (London, 1794).

