Pure silver (ingot) has a beautiful white colour and lustre ; it is almost as plastic as pure gold, and, like it, very soft. It does not tarnish in natural air ; but in air contaminated with ever so little sulphuretted hydrogen it gradually draws a black film of sulphide. The specific gravity of the frozen metal is 10∙42 to 10∙51, rising to 10∙57 after compression under a die. It is the best con­ductor of heat and electricity. The expansion of unit length from 0° to 100° C. is 0∙001936 (Fizeau). The specific heat is 0∙0570 (Regnault), 0∙0559 (Bunsen). It fuses at 954° C. (Violle)—*i.e.,* far below the fusing point of copper or gold—without oxidation, unless it be in con­tact with a surface of silicate (porcelain glaze, &c.), when a trace of silicate of Ag2O is produced. It volatilizes appreciably at a full red heat; in the oxyhydrogen flame it boils, with formation of a blue vapour. The fused metal readily absorbs oxygen gas (under fused nitre as much as twenty times its volume—Gay-Lussac). When the oxygenated metal freezes the absorbed gas goes off suddenly at the temperature of solidification, and, by forcing its way through the solid crust produces volcanic eruptions of metal which are sometimes very beautiful. The presence of even very little base metal in the silver prevents this “spitting,” the base metal combining with the oxygen faster than it can be reabsorbed. Pure silver retains a trace of the absorbed oxygen permanently, and Dumas in an experiment on one kilogramme of metal extracted from it 82 milligrammes of oxygen in an ab­solute vacuum at 400°–500o C. Water, and ordinary non-oxidizing aqueous acids generally, do not attack silver in the least, hydrochloric acid excepted,—which, in the presence of air, dissolves the metal very slowly as chloride. A solution of common salt acts similarly, the liberated sodium becoming NaOH. Aqueous hydriodic acid, even in the absence of air, dissolves silver perceptibly, with evolution of hydrogen (Deville). Aqueous nitric acid dis­solves the metal readily as nitrate ; hot vitriol converts it into a magma of crystalline sulphate, with evolution of sulphurous acid. Silver is absolutely proof against the action of caustic alkali leys, and almost so against that of fused caustic alkalies even in the presence of air. It ranks in this respect next to gold, and is much used to make vessels for chemical operations involving the use of fused caustic potash or soda. The ordinary “fine” metal is good enough for this purpose.

Silver Alloys.—Pure silver is too soft to make durable coins or vessels combining lightness with stability of form. This defect can be cured by alloying it with a little copper. All ordinary “silver” articles consist of such alloys. The proportion of silver in these (their “fineness”) is habitually stated in parts of real silver per 1000 parts of alloy. In Great Britain all silver coins are made of “standard silver,” the fineness of which, by legal definition, is 925. The toleration is 4 units (of pure silver in 1000 of alloy), *i.e.,* a specimen passes as long as its fineness lies between 925 and 921 (compare Mint, vol. xvi. p. 483). As regards silver- plate the “Hall” in London refuses to stamp any poorer alloy. In Germany and in the United States all silver coins, in France and Austria the major silver coins, are of the fineness 900, with a toleration of 3 units. The minor coins of Austria are of the fine­ness 375 to 520 ; in France all silver coins under one franc contain 835 of silver, 93 of copper, and 72 of zinc in 1000 parts. The fineness prescribed by law or custom for “ silver” articles is 950 or 800 (±5) in France, 750 in North Germany, 812∙5 in South Ger­many, and 820 in Austria. All *these* alloys at least are liable to “ liquation,” which means that, although they are perfectly homo­geneous in the crucible, they freeze into layers of not absolutely the same composition. According to Levai, passing from the skin to the core of an ingot of 900 per mille silver the difference may amount to 3 units. Of all the alloys tried by that chemist only that composed according to the formula Ag3Cu2, corresponding to 719 per mille of silver, remained perfectly homogeneous on freez­ing. He therefore recommends this alloy for coinage; unfor­tunately, however, any silver-copper alloy which contains less than about 750 per mille of noble metal tarnishes very perceptibly in the air. British standard silver is quite free of this defect, but it is inconveniently soft, far softer than the “ 900 ” alloy.

The extent to which the properties of silver are modified by addition of copper depends on the fineness of the alloy produced. The addition of even three parts of copper to one of silver does not quite obliterate the whiteness of the noble metal. According to Kamarsch the relative abrasion suffered by silver coins of the degrees of fineness named is as follows :—

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Fineness | 312 | 750 | 900 | 993 |
| Abrasion | 1 | 2∙3 | 3∙9 | 9∙5 |

The same observer established the following relation between fine­ness *p* and specific gravity in coins containing from 375 to 875 of silver per 1000 :—sp. gr. = 0∙001647*p* + 8∙833.

The fusing points of all copper-silver alloys lies below that of pure copper; that of British standard silver is lower than even that of pure silver. For the alloys of silver with other metals than copper, see Gold, Platinum, and Nickel. The present writer has introduced an alloy of 91 of silver, 7 of gold, and 2 of nickel as a material far superior, on account of its higher rigidity, to fine silver for the making of alkali-proof vessels.

“Oxidized” silver is ordinary cupriferous silver superficially modified by immersion into sulphide of sodium solution (which produces a dark film of sulphide), or otherwise.

*Silvering.—*For the production of a silver coating on a base- metallic object we have chiefly two methods. One of these is to dissolve silver in mercury and to apply this amalgam to the (care­fully cleaned) surface of the object by means of a brush. The mercury then is driven away by heat, when a coherent film of silver remains, which adheres very firmly, is quite continuous, and needs not be thick to stand polishing and other surface treatment. This very old method is to this day the best for producing a strong coating, but it is dangerous to the health of the workmen, expen­sive, and troublesome, and has been almost superseded by the modern process of *electroplating* (see Electro-Metallurgy, vol. viii. p. 116). Objects made of iron or steel must first be coated over with copper, and then treated as if they consisted of that metal.

For *Glass-Silvering,* see Mirror, vol. xvi. p. 500.

Inscriptions on linen, consisting of black metallic silver and consequently proof against all ordinary processes of washing, can be produced by using suitably-contrived silver solutions as inks. A mere solution of nitrate of silver (1 to 8 of water)@@1 will do, if the surface to which it is applied has been prepared by impregna­tion with a solution of 6 parts of soda crystals and 17 of gum arabic in 30 of water, and subsequent ironing. The ink must be applied with a quill or gold pen (compare vol. xiii. p. 81).

Silver Compounds.—(1) *Nitrate of Silver (*AgNO3*)* is made by dissolving fine silver in a moderate excess of nitric acid of 1∙2 sp. gr., applying heat at the end. The solution on cooling deposits crystals—very readily if somewhat strongly acid. Even a slightly cupriferous solution deposits pure or almost pure crystals. Any admixture of copper in these can be removed by fusing the dry crystals, when the copper salt only is reduced to black oxide of copper insoluble in water and thus removable, or by boiling the solution with a little pure oxide of silver (Ag2O), which precipitates the CuO and takes its place. Nitrate of silver forms colourless transparent sonorous plates, which, if free of organic matter, remain unchanged in the light,—which agent readily produces black metallic silver if organic matter be in contact with the salt or its solution. One hundred parts of water dissolve, of nitrate of silver—

|  |  |  |  |
| --- | --- | --- | --- |
| at 0° | 11° | 19o∙5 | 110° C. |
| 121∙9 | 127∙7 | 227 | 1111 parts. |

The solution is neutral to litmus. The salt dissolves in 4 parts of cold alcohol. Nitrate of silver fuses at 198° C. into a thin colour­less liquid, which stands even higher temperatures without decom­position. At a red heat it is reduced to metal. The fused salt, cast into the form of quill-sized sticks, is used in surgery as a cauterizing agent (“lapis infernalis,” or lunar caustic). The sticks gain in firmness if alloyed with a little nitrate of potash.

(2) *Sulphate of Silver* (Ag2SO4) forms white crystals soluble in 200 parts of cold or 68 of boiling water, but more soluble in dilute sulphuric acid. It stands a red heat without decomposition.

(3) *Oxide of Silver* (Ag2O) appears as a dark-brown precipitate when a solution of the nitrate is mixed with excess of caustic potash or—preferably for preparative purposes—baryta water. It is slightly soluble in water, forming a very decidedly alkaline (to litmus) solution, behaving as if it contained the (unknown) AgOH. It seems to suffer reduction in the light. In hydrogen it loses its oxygen at 100° C. (Wohler), in air from about 250° C. upwards. Solutions of numerous organic substances and other agents reduce oxide of silver, more or less readily, to metal. Bitter produced what he took to be a *peroxide* of silver by decom­posing a solution of the nitrate galvanically, in the form of black metallically-lustrous crystals, which gathered at the positive pole. At 110° C. these decompose almost explosively, with evolution of the 12,77 per cent. of oxygen demanded by Ag2O2 ; yet according to Berthelot the crystals are 4 Ag2O3. AgNO3 + 2H2O. But a hydrate of Ag4O3 is got by the action of peroxide of hydrogen on Ag2O.

@@@1 Preferably blackened for visibility by incorporation of some Chinese ink (carbon).