# All manner of antimony

**Claire Hansell** surveys the uses, past and present, for antimony, including an unusual method for 'recycling' it.

Traversing the periodic table, there are few elements whose chemical symbols are not derived from their full (English) name. Most are from the handful of metals known since antiquity. Whilst iron, gold or silver might spring immediately to mind, antimony is also part of this venerable 'old world' of elements. Its symbol Sb comes from the Latin *stibnum*, which also lends its name to the mineral in which antimony is most commonly found: stibnite ($Sb_2S_3$), used by Ancient Egyptians as an eye cosmetic owing to its rich black colour.

Ancient Greek and Latin authors referred to it using variants of the name *stibium*, so where did 'antimony', the medieval term that has stuck until the present day, come from? A popular, but most likely fanciful, etymology is that it is derived from the French *antimoine* meaning anti-monk. Many early alchemists were monks who believed it was possible to transform antimony into gold — but were unfortunately unaware of its toxicity and conducted alchemical experiments with not a lab coat or safety goggles in sight. More likely though is that the name derives from the Greek ἀντίμόνος (*antimonos*), meaning against aloneness, reflecting the fact that element 51 is rarely found naturally in its metallic state.

A metalloid, rather than a true metal, antimony exists in four allotropes: the most stable is metallic and grey; with a non-metallic yellow, a black and an explosive white form also known. Unusually, metallic antimony expands slightly upon freezing, one of only four elements known to do so. It generally forms compounds in its trivalent and pentavalent states. One example is the powerful Lewis acid $SbF_5$, which in combination with HF forms fluoroantimonic acid ($[H_2F][SbHF_6]$), the strongest known superacid (pH −31.3), which is even able to protonate hydrocarbons to form carbocations and molecular hydrogen.

Orange deposits of antimony pentasulfide ($Sb_2S_5$) at Champagne Pool, Rotorua, New Zealand. © Robert Harding World Imagery / Alamy

Antimony is poisonous by inhalation and ingestion, and it has also been found to be carcinogenic[1], although the exact mechanisms of its toxicity are still unclear. This, however, hasn't prevented element 51 from finding a role in medicine throughout history. As well as eye make-up, stibnite was used as a skin medication in Ancient Greece. In the Middle Ages, it was widespread practice for pellets of antimony to be swallowed whole to induce vomiting and as a laxative; this was in tune with the medical belief of the times that 'bad humours' needed to be expelled from the body. It was an expensive metal, and so pellets were often retrieved for re-use, and even passed on from generation to generation — whilst not the best medicine, this was certainly an innovative recycling method! A more refined alternative, generally used in the 1600s after the pellets were outlawed, was to drink wine that had been left standing in an antimony cup overnight.

Far from being an effective medical treatment, it has been suggested[2] that excessive use of antimony therapy may have contributed to Mozart's early death at just 35. Today some pentavalent antimony compounds have found proper medical use as treatments for leishmaniasis[3], a parasitic disease mostly found in the developing world.

One of the major current uses for element 51 is the incorporation of antimony trioxide as a flame retardant into plastics and other materials[4]. Alloying antimony with other metals has also long been used as a tactic to improve hardness and tensile strength; when Gutenberg invented the printing press in the 1400s, the metal type blocks were made from a lead–tin–antimony alloy. Today similar alloys are used for the plates in lead–acid batteries. Elemental antimony is also considered to be a promising anode material for high-energy density lithium ion batteries, owing to its high theoretical capacity when lithiated to $Li_3Sb$.

With the ever-increasing interest in more efficient semiconducting materials to further miniaturize transistors in integrated circuits, doping non-metals with antimony has also found use. Doped zinc oxide has been shown to act as a p-type (electron-conducting) semiconductor, and under certain oxidizing conditions can also result in a ceramic with variable resistance properties. Doping silicon to increase its hole-conducting properties (as an n-type semiconductor) is also under investigation[5].

From ancient times to the present day, from use of both the bulk metal and stibnite through to the careful incorporation of tiny amounts in alloys and ceramics, antimony has found all manner of applications. Future developments in electronics may well hinge on the precise location and environment of antimony atoms, arranged with just as much care as an Ancient Egyptian queen applying stibnite-based make-up. ❐

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## References

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Cd In Sn Sb Te I Xe Cs Ba La Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er