Heavy Metal On a Tungsten Basis with a High Radiation Absorption Capacity is an Alternative to Toxic Lead

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EU Directive 2011/65/EU (RoHS 2) regulates the use of certain hazardous substances in electrical and electronic equipment. Lead is ranked at the top of the list, even higher than mercury and cadmium. The heavy metal used as radiation shielding or for anti-scatter grids due to its high atomic mass is highly toxic and does not break down easily, which is why a weight proportion of only 0.1% is permitted in new electronic and electric equipment. It also has a low melting point of just 327°C, constituting an additional hazard in case of fire. The Bavarian company, Wolfram Industrie, offers an innovative, more environmentally friendly alternative with Triamet, a heavy metal alloy on a tungsten basis. Thanks to its specific high density and the resulting radiation absorption capacity, the dimensionally stable product that is available in both an iron-nickel and a copper-nickel binder phase even shields against gamma radiation. While tungsten is normally difficult to process, it can be shaped into blanks using a powder-metallurgical process in this form. Subsequently these blanks can be processed further with little effort.

Since tungsten is a very dense and heavy material with a density almost as high as gold, it is particularly well suited for restricting beam inlets in collimators or shielding against high-energy electromagnetic radiation. Dangerous gamma radiation and X-rays in particular can be contained thanks to the very high absorption value of the metal powder mixture. Due to the high melting point of Triamet at more than 1000°C—which is much higher compared to lead, there is no risk of melting in case of a fire. However, only powder-metallurgical processing is possible due to this special characteristic—for the production of Triamet, tungsten powder is mixed with iron and nickel or copper and nickel powders. Subsequent shaping is either realized hydraulically with binding agents and a press, or isostatically under great pressure of 2000 to 3000 bar. The former is suitable for smaller dimensions, the latter for large-scale components. The resulting green parts are sintered into semi-finished products in an electrically heated vacuum oven or in a reduced hydrogen atmosphere.

Sintering Process at 1500°C
Thanks to Nickel and Iron Binder Phase

Wolfram Industrie uses a nickel and iron binder phase for the production of Triamet, added to the tungsten powder at the rate of 3% to 10%. Nickel acts as a catalyst that accelerates diffusion processes on the surface of the tungsten power and thereby reduces the sintering temperature by about 1000°C. Subsequently, the Triamet green parts are sintered at about 1500°C—in contrast to the 2500°C required for pure tungsten so that a unique microstructure with a spherical tungsten phase encased by the binder phase is formed.

Wolfram Industrie produces Triamet with a very high density. It is declared at G19 and is about 18.8 ±0.2 g/cm³. A maximum density of 19.3 can be achieved with pure tungsten, which in fact is about 8 g/cm³ higher than lead. The lower the proportion of the binder phase the higher the density will be. With the G14 version of the product for example, the minimum density is 13.9 ±0.2 g/cm³.

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Diverse Uses of Tungsten and Triamet in Medical Technology

A mixture of tungsten granulate and epoxy resin is used as a backing material in ultrasound heads (transducers) to minimize interfering acoustic reflections. Here the acoustic impedance of the backing material is increased by adding tungsten. Triamet is used in radiation therapy to shield against hard gamma radiation. Compared to lead frequently used for medical technology applications in the past, space-saving Triamet sets itself apart in that it does not need any supporting structure due to its high resistance. (Source: Wolfram Industrie)
Radioactive seeds that are delivered to a tumor and subsequently removed again during HDR brachytherapy can be stored in containers made of Triamet. Shielding vials for radiopharmaceuticals to reduce the radiation exposure of employees constitute another possible application. It is also suitable for isotope containers thanks to its dimensional stability that ensures easy cleaning and sterilization. Tungsten is atoxic and not environmentally hazardous according to its RoHS conformity, so that no coating is required. In addition to shielding elements for medical diagnostics and radiation therapy, Triamet can also be used as a material for micropipes and electron microscopes. Compared to lead frequently used for these applications in the past, space-saving Triamet that meets the requirements according to ASTM B777 also does not need any supporting structure due to its high resistance.

Triamet is available as an S and G-material. The binder phase of the former consists of copper and nickel. It is paramagnetic and only weakly magnetisable, making it suitable for use in the proximity of stronger magnetic fields, for example in magnetic resonance tomographs.

The binder phase of the G-material is constructed from iron-nickel compounds and, in contrast to the S-material, is ferromagnetic.

The lower the proportion of the binder phase, the higher the density will be – indicated here by the numbers “17” and “18”. However, the ductility of the heavy metal also increases as the binder proportion rises. (Source: Wolfram Industrie)

Universal Uses of the Heavy Metal Powder Also in Other Fields of Application

Aside from use in medical technology applications, Triamet is often used as a counterweight or balancing weight in the automobile industry. Additionally, Triamet is utilized in aluminum casting due to its very good durability and extremely low wear.

The Triamet product is used in mechanical engineering and plant construction as well because the material, with its high modulus of elasticity and the microstructure typical for sintered materials, provides excellent damping characteristics, making the material capable of considerably reducing vibrations.

Compared to steel, Triamet workpieces with 340 to 390 GPa provide a modulus of elasticity, which is almost twice that of the commonly used V2A steel with 200 GPa. This increased modulus of elasticity reduces deflection under the same load by 40%. To learn more about Triamet, the alternative to hazardous materials available from Wolfram Industrie, visit: www.wolfram-industrie.de

“Our material developments result from a mix of empirical experience and theoretical insights,” explains Dipl.-Ing. Wolfgang Jung, metal expert responsible for research and development at Wolfram Industrie. “Often the idea for a new material or a new process emerges through cooperation with our customers. As a rule, there are clear requirements here. Cooperation with universities is also very valuable to us for implementation.” (Source: Wolfram Industrie)

Company Profile:

Originally founded in 1911 as Wolfram Drahtfabrik GmbH for the production and processing of tungsten and molybdenum by the great-grandfather of today’s managing partner, Marion Freifrau von Cetto in Berlin, the company was renamed to Gesellschaft für Wolfram Industrie mbH in 1928. The company’s headquarters were moved to Traunstein in 1943, where additional production buildings were constructed in the 1950s. After the death of the shareholder, Helga Freifrau von Cetto, her daughter Marion Freifrau von Cetto as the owner took over management of the company in 1974. In 1991, the Gesellschaft für Wolfram Industrie mbH acquired the competitor Bayerische Metallwerke GmbH in Dachau that had been active in the market since 1926, thereby expanding its product range. There are currently 57 employees at the Dachau location and 63 in Traunstein. www.wolfram-industrie.de