EB glass melting electrodes

This article explains the use of recycled molybdenum for the manufacture of electron beam glass melting electrodes.

Molybdenum's high melting point, resistance to sagging at glass bath temperatures, high electrical conductivity, and resistance to attack by most glasses make it an ideal material for furnace components. Its very slow and gradual dissolution in molten glass occurs without discolouration or other detrimental effects to the glass. As well as electrodes, other glass processing components such as stirrers, pumps, bowl liners, wear plates and some moulds are made of molybdenum. Extruded molybdenum pipes are used in some plants to transport molten glass from one furnace to another. HC Starck supplies molybdenum electrodes and other components to customers throughout the world, from manufacturing and distribution sites in several countries.

There are a number of reasons why molybdenum is a very good choice for electric heating in the glass melting process. These include:

- its high strength at operating temperatures
- its high electrical conductivity
- its low thermal expansion coefficient
- its resistance to erosion and chemical attack
- it can be machined easily, and
- molybdenum oxides will not discolour most glasses.

An integral part of glass melting technology

HC Starck's molybdenum glass melting electrodes meet or exceed all industry standards for efficient glass melting and electrically boosted melting. The high temperature strength and rigidity of molybdenum electrodes, along with their inherent electrical properties, provide maximum furnace operating efficiency. The purity level of the molybdenum electrodes (at least 99.95%) assures outstanding resistance to chemical erosion and degradation and minimises detrimental glass discolouring.

HC Starck provides glass manufacturers with a number of purchasing options, and can provide glass melting electrodes with centreless ground, machine-finished surfaces to ensure concentricity and straightness. The company can also provide glass melting electrodes in a 'hot worked, chemically cleaned and straightened' condition. HC Starck's 5,000 metric tonne (5,500 ton) extrusion press produces very large diameters (up to 8 inches/200 mm) and longest lengths, comparable with anything that is already available. Glass melting electrodes are available with standard or tapered threads for easy assembly or can be machined with complex thread forms according to the customer's requirements.

HC Starck produces glass melting electrodes by the following two production processes:

- traditional powder metallurgical processing, and
- Molymelt EB melting.

Glass melting electrodes made by electron beam melting

The development of electric glass melting is heavily dependent on the development of electrode materials. There are very few electrode materials available which can fulfil the mechanical, electrical, process, corrosion and cost conditions of the glass melting process. Molybdenum has been the standard choice for decades, because of its high-temperature strength, good electrical conductivity and corrosion resistance to most glass compositions.

Fig 1. EB electrodes from HC Starck.

HC Starck uses the electron beam (EB) melting process to manufacture Molymelt EB glass melting electrodes. EB melting technology uses recycled molybdenum as its raw material, which is prepared by being 'bombarded' with electrons in the furnace. The material melts and falls into a water-cooled copper mould, where it solidifies into a round molybdenum ingot. The ingot is then forged and formed into the desired shape.

EB melting is carried out under a high vacuum, so that elements with melting points lower than molybdenum volatilise, leaving the molybdenum more than 99.95 per cent pure and 100 per cent dense.

Protective coatings on molybdenum

Anti-oxidation coatings are also available. They can be applied either by thermal spraying or by chemically reacting the metal surface to form the coating which is known either as Muride 'SP' or Muride 'T' coating. Primarily developed for use in the aerospace and glass industries, Muride 'SP' and 'T' coatings can coat element materials for use in air at temperatures of up to 2000°C.

The Muride coating process provides Molybdenum and other refractory metals with excellent protection against oxidation at high temperatures. It is a ceramic coating that, when applied to molybdenum, has the nominal composition $MoSi_2$. As it is integral to and chemically bonded to the metal surface, it cannot separate or spall. The normal coating thickness is ~125mm and is applicable to virtually any shape component. As it is produced from a gas phase it is possible to vary the coating thickness and apply the coating uniformly to all surfaces, including the inside of thin tubes.

Reliable and reproducible, Muride coating gives protection against oxidation from air, oxygen-rich atmospheres, oxidising chemicals and flames. The coating is fully compatible with Molybdenum and is suitable for the coating of glass melting electrodes and other components for the glass industry, protecting them from oxidation during the critical start-up period. As the coating is silica based, dissolution has no colouration or other detrimental effects upon glass.

The glass melting electrodes shown in ***fig 4*** demonstrate the effect of heating uncoated and coated glass melting electrodes in air to a temperature of 1100°C.

Muride coating has been successfully applied to the following over the course of the past 40 years:

- rocket nozzles and guide vanes
- turbo-jet engine blades, blast deflectors and silencers
- furnace heating elements, coils, racks, rollers and conveyors
- hot extrusion dies for ferrous and non-ferrous metals
- glass melting electrodes
- plate heating elements for glass furnaces, and
- stirrer rods, dies and casting nozzles for the glass industry.

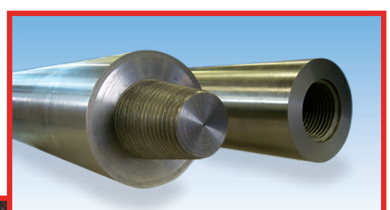

Fig 2. Dual threads for EB electrodes.

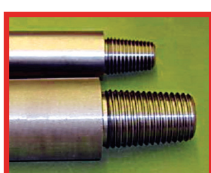

Fig 3. Tapered threads are offered too.

Fig 4. The effect of heating uncoated and coated electrodes.

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