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NASA TECH BRIEF



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Refractory Metals Welded or Brazed With Tungsten Inert Gas Equipment

The problem: To weld or braze certain metals, including refractory metals, which are difficult or impossible to join by conventional welding or brazing methods. In order to obtain satisfactory bonds between such metals, using tungsten inert gas (TIG) welding equipment, the welding or brazing (with appropriate brazing or filler metals) must be performed at prescribed temperatures and under protective atmospheres for some metal combinations.

The solution: Appropriate brazing metals, brazing temperatures, and welding temperatures are prescribed for a number of base metals that cannot be satisfactorily bonded by conventional methods. When the prescribed temperatures and specific brazing metals are used, the base metals can be firmly welded or brazed with TIG equipment. Inert atmosphere chambers must be used for certain metal combinations.

How it's done: When a brazing metal is used, the operation is performed at a temperature above the melting point of the brazing metal but below the melting points of the base metals to be joined. At this temperature, the molten brazing metal flows into the base-metal seam and forms a tight metal-to-metal bond on cooling. Brazing metals consisting of columbium-1% zirconium at approximately 4,400°F or titanium at approximately 3,300°F have been used to join tantalum to tungsten, tungsten to molybdenum, and molybdenum to tantalum. Molybdenum has been joined to stainless steel using the following brazing metals at the indicated approximate temperatures: 304 stainless steel at 2500°F; silver solder at 1200° to 1900°F; Inconel at 2500°F; gold-silver solder at 1900°F; and oxygen-free, high-conductivity copper at 1980°F.

The following metals have been brazed using specific silver solder formulations at 1200° to 1900°F: beryllium copper to beryllium copper; stainless steel to stainless steel; brass to stainless steel; copper to stainless steel; and aluminum to stainless steel.

To join two base metals by welding (without the use of a brazing metal or a flux) the welding temperature is kept for a short time at or above the melting point of the lower melting metal, but below the melting point of the other metal. The molten surface layers of the lower melting metal wet the second metal and form a metal-to-metal bond on cooling. This welding operation is preferably carried out in an inert-gas medium to protect the weld puddle from the atmosphere. The following pairs of base metals have been welded by this method. (The approximate temperature at which the second metal in each pair wets the first metal is given in parentheses.): Tungsten to columbium (4500°F); molybdenum to stainless steel (2700°F); stainless steel to copper (2000°F); molybdenum to copper (2000°F); and tantalum to copper (2000°F).

Notes:

1. The highest quality bond is obtained when TIG welding is performed in an inert-gas welding chamber or under an inert-gas blanket.
2. Metal plating on small parts or on localized areas of large parts can be performed using TIG equipment as prescribed above.
3. Inquiries concerning this innovation may be directed to:

Technology Utilization Officer
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Reference: B65-10319

(continued overleaf)

Patent status: NASA encourages commercial use of this innovation. No patent action is contemplated by NASA.

Source: John P. Wisner
(Lewis-219)