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FINAL ANALYSIS

Melting the PGMs: The State of the Art in Welding Platinum

A previous "Final Analysis" in this two-part series introduced the thermodynamics of platinum and discussed methods of casting platinum and its alloys for jewellery use (1). Here welding as a means of assembling cast platinum components into finished products is discussed.

Welding: A Miniature Casting Operation

Casting section by section and welding reduces the amount of expensive platinum alloy in process at any time. Because of its low thermal diffusivity (1), platinum can be assembled by precision welding very satisfactorily. The same welding systems may be very useful in cleaning up minor casting defects and for jewellery repair. Adjusting the power density to precise targets is more quickly learned than with traditional torch welding but the capital cost of such precision welding systems has to be considered.

Welding is a miniature casting operation; much the same heat flow arguments apply. The least expensive capital option is a torch with bottled oxy-acetylene, -natural gas or -butane. The possibility of carbon pickup from reducing flame conditions is not great because a reducing flame is scarcely adequate for platinum welding temperatures and is therefore easily avoided. An oxy-hydrogen torch is cleaner but lacks luminosity until boosted by running the gas through denatured alcohol. Without luminosity the torch is more difficult to work with, as the very pale blue flame is almost invisible against the increasingly reflective background of platinum as it is heated. One of the most popular oxy-hydrogen generators and torch welders was developed by Johnson Matthey and is now manufactured by Sherwood Scientific Ltd (2) and sold widely by distributors including A G Thomas (Bradford) Ltd for between £1000–£2000 dependent on unit size (Figure 1) (3–5). Flame torches lose a lot of heat to surroundings; precise control requires frequent jet/nozzle and fuel flow changes.

Platinum Jewellery Welding

Electric welding is very effective with platinum group metal (pgm) jewellery alloys using single-phase mains input power less than 1.7 kW. The brief peak power of the pulse focused on a sub-millimetre target (it can be as small as 20 μm with the laser beam) produces a high power density relative to the small volume of metal. The relatively low thermal diffusivity of the pgms (1) restricts the heat-affected zone very effectively. Pulse argon arc welders such as Lampert Werktechnik GmbH's PUK® machines based on tungsten inert gas (TIG) arc welding technology are very versatile, easy to learn to use and less than a third of the price of a low-end laser. The best equipped jewellery makers may use both PUK and laser welders in slightly different ways. The PUK welder pulls the arc into the target; while the laser 'probes'. The PUK welder electrode can usually be manoeuvred around larger objects than the laser; the pulsing rate is slower than the laser. Where a lot of welding or filler metal is needed such as in spun hollow ware the pulsing becomes virtually continuous TIG arc welding (6) often with a jig or rotor. Welds can be planished and polished.

The price of jewellery laser welders has fallen to under £20,000 and there is a new generation of compact 'table top' machines at about £16,000. In the US, Rio Grande is the largest supplier of laser welders and they market a tabletop version under the brand name PulsePoint™ Studio™ from Neutec USA (Figure 2) (7). There is also a machine on the market which offers an advanced constant voltage power supply that allows welding at a substantially reduced peak power; avoiding high peak power pulses doubles the life of the expensive laser flash tube.

Conclusions

In the last twenty years the jewellery industry has adopted sophisticated techniques for melting, casting and joining the platinum group metals. This has been achieved by matching the heat energy density to an optimum geometry target. Highly localised welding power is achieved by pulsing and very fine focusing on targets frequently less than a millimetre in diameter.

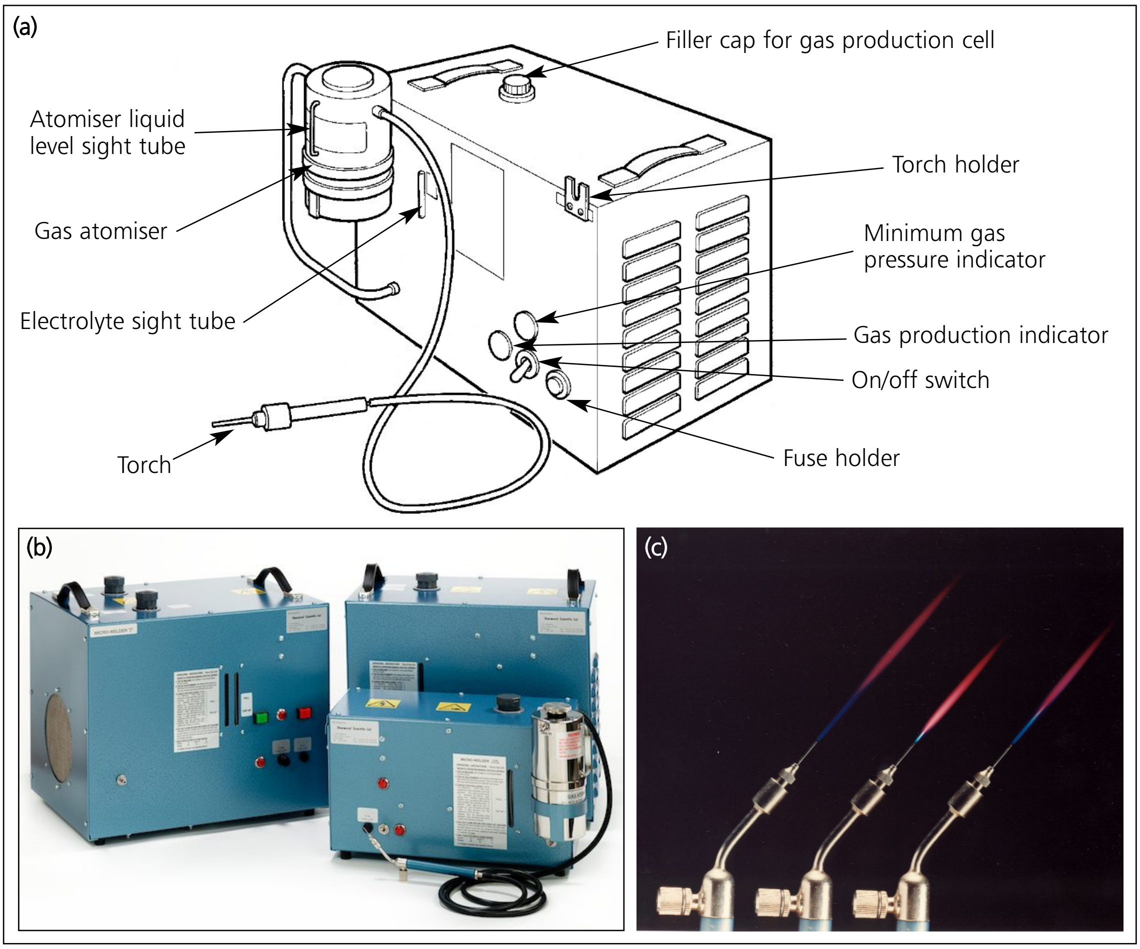

Fig. 1. (a) Schematic diagram of a microwelder (3); (b) A range of microwelders; (c) Microwelder torch flames showing boosted luminosity (Figures 1(b) and 1(c) courtesy of Sherwood Scientific Ltd (4) and A G Thomas (Bradford) Ltd (5))

Fig. 2. Neutec USA PulsePoint™ Studio™ 60 tabletop laser welder supplied in the US by Rio Grande (Image courtesy of Rio Grande, USA) (7)

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