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Welding silver and silver alloy containers for high-temperature and high-pressure experiments

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Many experiments at high temperature and high pressure require closed chemical systems. The containers required for such work are usually fabricated from noble metal, typically Au, Pt, Ag, or Ag-Pd alloy. The latter two metals are preferred for much experimental work for several reasons: they are much less expensive than Au or Pt, they dissolve little or no Fe and, in the case of certain Ag-Pd alloys, are highly permeable to H.

The requirement of a closed system also requires that the containers be sealed in some way. This is usually done by fusion welding. The ideal welding apparatus for such use should be safe, simple, reliable, inexpensive, and easily mastered by student research assistants.

The simple electric carbon-arc welding system is widely used, satisfies most of the above criteria, and is, in general, preferable to other welding systems. It is much safer in inexperienced hands and less expensive than gas welding. It is much less expensive than the tungsten–inert gas or similar electric welding systems using an inert masking gas around the weld puddle.

However, the common, usually home-made, carbon-arc welder is virtually useless for welding Ag or Ag-based alloys. The problem arises from the solubility of oxygen in liquid Ag (Hansen and Anderko, 1958). Oxygen from air dissolves in the melt during fusion, but is then expelled from the melt during solidification. The result is a very porous and permeable joint that is virtually certain to be unusable.

A simple procedure excludes oxygen from the melt during fusion and allows the simple electric carbon-arc welder to be used for reliable, routine welding of silver and silver alloys. The procedure uses water vapor as the masking gas to exclude oxygen from the weld puddle. A laboratory tissue or paper towel is wet with distilled water and placed within 0.25 to 2 mm of the metal joint to be welded. The joint is now ready to be welded in the usual fashion. When the arc is struck, the water boils, producing water vapor adjacent to the fusion puddle and displacing the air. The resulting welds are sound and typically very smooth. The water also prevents the sample from being overheated, a beneficial side effect.

References cited

Hansen, M., and Anderko, K. (1958) Constitution of binary alloys. McGraw-Hill, New York.

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