B. Issues in Welding of Light Metals: Self-shielding welding consumables for aluminum alloys and weldability of magnesium-lithium alloys

G.J. Atkins and D.L. Olson, Colorado School of Mines, Golden, CO

Introduction

Welding is and will continue to be integral to building and maintaining the US defense force. As the militaries use of light metals such as aluminum, magnesium, and titanium increases so will the welding demands. Currently two research initiatives are in progress in the area of light metals welding: 1) development of an aluminum FCA welding consumable and 2) weldability of superlight magnesium-lithium (Mg-Li) alloys. Development of an effective self-shielding aluminum consumable that can be used in a portable welding torch would allow for quick repairs by a moderately skilled welder. Formable and weldable Mg-Li alloys would allow for the fabrication of complex assemblies that are extremely light.

Technical Approach

Two self-shielding methods for aluminum welding have been investigated. In the first method various salt-based fluxes, which are traditionally used for aluminum SMAW, were investigated using a submerged arc process. In contrast a more novel technique for self-shielding by storing inert gas in zeolite powders, which can be placed in a cored wire, was explored. Experiments were conducted to determine storage capacity of several zeolite powders. Subsequently, the powder was incorporated into an aluminum cored wire.

On an adjacent light metals front, an investigation into the weldability of two unique Mg-Li alloys was conducted using the GTAW process. Autogenous welds were characterized along with dissimilar welds to traditional magnesium alloys.

Results/Discussion

Currently there is no aluminum FCAW wire on the market. There are a number of aluminum SMAW consumables available, but they are notoriously difficult to weld and in most cases only produce marginal quality welds. After investigation of the literature and experimentation of salt fluxes it was decided to pursue other avenues due to poor weld quality, arc instability, and possible health and environmental issues from fluoride and chloride compounds in the fumes. Therefore, work has been performed looking at the inert gas storage capacity of zeolites. Zeolites, which are commonly used as molecular sieves, have a highly porous structure. A variety of tests have been performed on two types of zeolite powders (grade 3A and 4A) to determine best method of storing gas in the porous structure, the quantity of gas that can be stored, and desorption rate. A small batch of aluminum wire with a zeolite core was fabricated and welded. Subsequently, a thorough metallographic analysis was performed.

Magnesium alloyed with over 10-wt.pct. lithium can be transformed from its normal hexagonal-close packed α-phase into a single body-centered cubic β-phase, with a two phase region existing between 5 and 10-wt.pct. By adopting the crystal structure of lithium, ductility and formability of the new magnesium alloys can be improved. While magnesium is commonly cast to produce near-net shapes, the fusion welding of wrought magnesium alloy sheets with improved ductility may offer economical advantages to fabricate complex assemblies. In this research, the microstructures and properties of autogenous gas-tungsten arc welds on two Mg-Li alloys (7.5-wt.pct and 10.2-wt.pct lithium) were described and analyzed. In addition, dissimilar welds were made between the Mg-Li alloys and several commercial magnesium alloys.

Conclusions

Preliminary investigation into salt fluxes for aluminum welding found that the risks involved necessitated research of alternate weld shielding methods. Therefore a novel approach of using a porous zeolite powder to store inert gas was investigated. Work to characterize the ability of zeolites to store inert gas and the weldability of an aluminum welding wire with a zeolite core has been conducted. Also, preliminary work has been conducted to characterize the weldability of Mg-Li alloys.