JERVOIS MINING LIMITED
A.B.N. 52 007 626 575

Aluminium Scandium Alloys

Worldwide demand for scandium at the moment is relatively small with countries such as the USA only consuming around 2tpa of scandium oxide. The future demand however appears to be very positive with the most interest coming from Japanese and European companies seeking reliable sources of scandium oxide for use in fuel cells. Other uses for scandium include aluminium alloys which are likely to be used for aerospace and ship building. Advances in welding techniques such as Friction Stir Welding (FSW) have reduced construction costs by reducing labour costs. Machines are able to join prefabricated panels, which can be manufactured off-site for later installation. This means that less specialised labour is required for welding and production time is significantly reduced. For large projects such as ship building and aerospace this saves millions of dollars in construction costs and eliminates the need for welding materials which can be hazardous to workers and the environment.

Friction Stir Welding (FSW) was developed in the 1990's at the The Welding Institute UK and is a process whereby a tool bit is rotating at speed between two pieces of sheet or plate metal. Friction heat is generated causing the material to soften without reaching melting point and as the tool moves forward the material is forced around and consolidated at the back of the tool bit. FSW is suitable for Al-Sc alloys because the processing temperature occurs well below the melting point of the metal which eliminates chemical reactions which can introduce impurities to the weld joint. Weld strength is excellent when compared with high temperature fusion such as arc welding. No gas shielding is required or metal filling materials, which results in a joint with less contamination than arc welding. If correctly set up this type of welding produces more consistent results than tradition welding which is vital in high stress applications such as aerospace where failure can be catastrophic.

NASA are testing Al-Sc alloys in the development of fuel tanks and air frames for vehicles such as the Hypersonic-X where weight and compatibility with hydrogen peroxide is critical. To be suitable for long term contact with H_2O_2 the alloy must meet Class 1 specifications. The current 5000 series Al-Mg meets this criteria, however lacks strength for aerospace applications. Higher strength alloys have generally been incompatible for long term H_2O_2 storage and it was therefore necessary to find alternatives. By adding scandium (Sc) and zirconium (Zr) to aluminium 5254 this increased strength, and was still compatible for H_2O_2 storage. This became C557, containing Al-Mg-Sc-Zr, produced by Alcoa and heat treated to ensure good stress corrosion resistance. This material is not further heat treatable and therefore strength cannot really be increased without further addition of other materials. Alloys that are heat treatable are 7X0X and 7X11 which are compatible with H_2O_2 but are not as corrosion resistant as C557. FSW has been tested and shown to be a very effective type of welding for the construction of H_2O_2 tanks with minimal contamination of the joint area.

In conclusion, alloys such as 7X11 containing scandium would be the most suitable for aerospace applications and are able to utilise friction stir welding . For other industries where extreme high strength is not so critical, C557 which is more corrosion resistant, provides a better alternative than 5254 and is being tested for application in the maritime industry. This alloy also contains scandium, which can be FSW and will most likely be used in the construction of US naval ships.

Source: www.sti.nasa.gov