Magnesium Elektron

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Factors Contributing to the Corrosion Resistance of Elektron 21 (EV31A)

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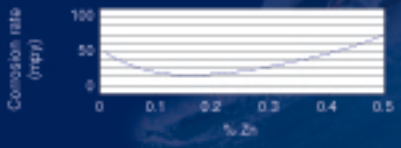
Elektron 21 (ASTM Designation EV31a) is a Mg-RE-Zn-Zr sand casting alloy targeted to fulfil the needs of applications where a good package of castability, mechanical properties and corrosion performance are required. Designed for Aerospace and Speciality Applications, the alloy is capable of operating up to approximately 200°C (400°F). Elektron 21 can compete successfully with much heavier aluminium-based alloys.

Corrosion performance can be variable in high purity magnesium alloys until factors influencing this behaviour are fully understood. Investigations to understand the corrosion behaviour of Elektron 21 included analysis of the effects of composition, heat treatment and surface preparation. By controlling the chemistry of the alloy and eliminating sand cast surface effects, Elektron 21 achieves corrosion rates within the range 10-30mpy (0.1-0.4mcd).

Composition

Of the major alloying elements, Zn and to a far lesser extent Gd influence corrosion performance.



Zn was found to be detrimental at both high and low levels within the range 0-0.75%. When no Zn was present, "exfoliation" corrosion was observed, of the type that has been reported for unalloyed Mg.

As Zn content increased, corrosion was associated with microscopically coarse precipitates within individual grains. This type of precipitate increases with Zn content.

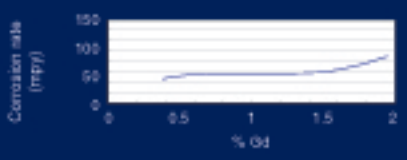
Elektron 21 (0.75% Zn)

Corrosion generally occurring at cored precipitates

Elektron 21 (0.2% Zn)

Less cored precipitates and very little corrosion

Gd had a less significant effect on corrosion than Zn.



Controlling Zn within the range 0.2-0.55% and Gd up to 1.75% gave good corrosion performance, comparable with other corrosion resistant alloys e.g. Elektron WE43 and High Purity AZ91E.

Heat Treatment

Heat treatment condition can influence the corrosion of Mg alloys. This can be dependant upon whether microscopic segregation of cathodic phases can be dissolved and dispersed during the heat treat process.

Heat treatment variations evaluated included:

Solution Treat* – Hot Water Quench – Age**
Solution Treat* – Cool in Still Air – Age**
Solution Treat* – Fan Air Cool – Age**

*8hrs at 520°C (968°F)

**16hrs at 200°C (392°F)

Overall a slow cool (<2°C)after solution treatment generated poorer corrosion resistance, whilst the faster water quench gave good results.

Examination of the microstructure showed that coring within the grains of slow cooled material was less evident than in quenched material and precipitation was coarser. This coarser precipitate was attacked preferentially leading to some reduction in corrosion performance.

Elektron 21 Hot Water Quenched

Little corrosion generally occurring at cored precipitates

Elektron 21 Still Air Cooled

Precipitate more widely distributed within the grain. Greater surface area of precipitate provides more initiation points for corrosion

Quench rates have been optimised to achieve corrosion performance combined with good mechanical properties.

Surface Preparation

In common with other high purity alloys, the surface condition of Elektron 21 can greatly effect corrosion performance.

Sand cast Elektron 21 surface preparation treatments evaluated included:

Alumina Shot Blasting
Acid Cleaning
Acid Cleaning + Hydrofluoric Acid (HF)
Mechanical Abrasion

Typical Corrosion Rates

Alumina-Shot Blasting	200-500mpy (2.5-6.4mcd)
Acid Cleaning	20-60mpy (0.3-0.8mcd)
Acid Cleaning + HF	10-20mpy (0.1-0.3mcd)
Mechanical Abrasion	10-30mpy (0.1-0.4mcd)

Removal of 0.05 – 0.20mm of metal from the surface during acid pickling improves corrosion performance of Elektron 21. This is thought to be due to elimination of sand cast surface effects.

Corrosion performance can be further enhanced by use of HF treatment after acid cleaning.

Mechanical abrasion also removes sand cast surface effects. Abrasion using a fine grade metallurgical grinding paper, can offer a smoother surface finish than acid pickling, thus further improving the corrosion performance.