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(54) Titre : ALLIAGE ALUMINIUM-MAGNESIUM SOUDABLE, A HAUTE TENEUR EN MAGNESIUM, RESISTANT A LA CORROSION, DESTINE NOTAMMENT A DES APPLICATIONS DANS L'AERONAUTIQUE

(54) Title: WELDABLE ANTI-CORROSIVE ALUMINIUM-MAGNESIUM ALLOY CONTAINING A HIGH AMOUNT OF MAGNESIUM, ESPECIALLY FOR USE IN AVIATION

(57) Abrégé/Abstract:
Weldable, high-magnesium-content aluminum-magnesium alloy consisting of at least 5 - 6 %w/w magnesium (Mg), 0.05 - 0.15 %w/w zirconium (Zr), 0.05 - 0.12 %w/w manganese (Mn), 0.01 - 0.2 %w/w titanium (Ti), 0.05 -- 0.5 %w/w of one or more elements from the scandium group and/or terbium (Tb), wherein at least scandium (Sc) is included, 0.1 - 0.2 %w/w copper (Cu) and/or 0.1 - 0.4 %w/w zinc (Zn), along with aluminum (Al), and unavoidable contamination does not exceed 0.1 %w/w silicon (Si).

ABSTRACT

Weldable, high-magnesium-content aluminum-magnesium alloy consisting of at least 5 - 6 %w/w magnesium (Mg), 0.05 - 0.15 %w/w zirconium (Zr), 0.05 - 0.12 %w/w manganese (Mn), 0.01 - 0.2 %w/w titanium (Ti), 0.05 - 0.5 %w/w of one or more elements from the scandium group and/or terbium (Tb), wherein at least scandium (Sc) is included, 0.1 - 0.2 %w/w copper (Cu) and/or 0.1 - 0.4 %w/w zinc (Zn), along with aluminum (Al), and unavoidable contamination does not exceed 0.1 %w/w silicon (Si).

WELDABLE ANTI-CORROSIVE ALUMINIUM-MAGNESIUM ALLOY CONTAINING A HIGH AMOUNT OF MAGNESIUM, ESPECIALLY FOR USE IN AVIATION

The invention relates to a weldable, corrosion-resistant, high-magnesium-content aluminum-magnesium alloy, which contains a ternary aluminum-scandium-zirconium phase as the essential component. Such an alloy is known from US 5,624,632, for example, and is of interest above all for applications in aeronautics due to its low density, high strength and corrosion resistance. Adding rare earth or rare earth-like elements generates dispersoids in the aluminum-magnesium alloy, which produce a higher strength and corrosion resistance according to the above US patent. The above US patent makes no statement as to the weldability of such an alloy.

An object of this invention is to provide a weldable, corrosion-resistant, high-magnesium-content aluminum-magnesium alloy, which is at least as good as the known alloy in terms of strength and corrosion behavior, and exhibits a high recrystalization threshold to go along with a good weldability.

The present invention provides a weldable, corrosion-resistant high-magnesium-content aluminum-magnesium alloy comprising:

5 to 6 %w/w magnesium (Mg);

0.05 to 0.15 %w/w zirconium (Zr);

0.05 to 0.12 %w/w manganese (Mn);

0.01 to 0.2 %w/w titanium (Ti);

0.05 to 0.5 %w/w of scandium and optionally at least one lanthanide;

0.1 to 0.2 %w/w copper (Cu); and

0.1 to 0.4 %w/w zinc (Zn);

the balance being aluminum (Al);

wherein unavoidable contamination does not exceed 0.1 %w/w silicon (Si).

The present invention also provides a weldable, corrosion-resistant, high-magnesium content aluminum-magnesium alloy comprising a ternary aluminum-scandium-zirconium phase and consisting essentially of:

5 to 6% by weight magnesium (Mg);

0.05 to 0.15% by weight zirconium (Zr);

0.05 to 0.12% by weight manganese (Mn);

0.01 to 0.2% by weight titanium (Ti);

0.05 to 0.5% total by weight of scandium (Sc), terbium (Tb), and optionally at least one additional element which is a lanthanide, wherein scandium (Sc) and terbium (Tb) are present as mandatory elements, with said terbium (Tb) replacing part of the scandium content such that the amount of terbium (Tb) is larger than the replaced part of the scandium content; and

at 0.1 to 0.2% by weight copper (Cu) or 0.1 to 0.4% by weight zinc (Zn), or both;

the balance being aluminum;

wherein unavoidable contaminants do not exceed 0.1% by weight silicon.

In comparison to the known alloy, this new alloy exhibits above all a distinctly lower manganese share, wherein an improved corrosion resistance was surprisingly found, primarily in the sensitized state of the parts made out of this alloy, e.g., when cold-formed parts are subjected to an elevated temperature over a prolonged period. It is assumed

that these positive properties are determined primarily by the ratio of manganese to scandium. An improved corrosion resistance is observed at a ratio of Mn to Sc < 2. Along with acting as a grain growth inhibitor, the

titanium share not present in the known alloy helps to increase strength, since titanium can replace the zirconium in the ternary Al-Sc-Zr phase, wherein the solubility of titanium is lower than that of zirconium, however.

The addition of Cu and/or Zn increases the strength, which can be traced back to the known high strength of the Al-Cu or Al-Zn phase. The respective upper concentration limits are selected to prevent the Cu from diminishing the weldability above all, and the Zn from diminishing the corrosion resistance.

It has also been shown that scandium can be replaced by terbium, at least within certain limits. However, more terbium than the amount of scandium being replaced must be added to achieve constant properties.

A particularly strong and corrosion-resistant alloy contains at least 0.15 %w/w scandium. Lanthanidene is preferably added in amounts ranging from 0.05 and 0.35 %w/w, wherein this range relates to the total mixture when using a lanthanidene mixture. The alloy tolerates silicon contamination of up to 0.1 %w/w; primarily the dynamic properties deteriorate at above this level.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A weldable, corrosion-resistant high-magnesium-content aluminum-magnesium alloy comprising:

5 to 6 %w/w magnesium (Mg);

0.05 to 0.15 %w/w zirconium (Zr);

0.05 to 0.12 %w/w manganese (Mn);

0.01 to 0.2 %w/w titanium (Ti);

0.05 to 0.5 %w/w of scandium and optionally at least one lanthanide;

0.1 to 0.2 %w/w copper (Cu); and

0.1 to 0.4 %w/w zinc (Zn);

the balance being aluminum (Al);

wherein unavoidable contamination does not exceed 0.1 %w/w silicon (Si).

2. An AlMg alloy according to claim 1, wherein the ratio of manganese to scandium is less than 2.

3. An AlMg alloy according to claim 1 or 2, wherein at least 0.15 %w/w scandium (Sc) is included.

4. An AlMg alloy according to any one of claims 1 to 3, comprising 0.05 to 0.35 %w/w of said at least one lanthanide.

5. An AlMg alloy according to claim 4, wherein said at least one lanthanide is cerium (Ce), neodymium (Nd), europium (Eu), gadolinium (Gd), dysprosium (Dy), holmium (Ho) or erbium (Er), or any combination thereof.

6. An AlMg alloy according to any one of claims 1 to 4, wherein said at least one lanthanide is terbium.

7. A welded component for an airplane comprising an AlMg alloy as defined in any one of claims 1 to 6.

8. A weldable, corrosion-resistant, high-magnesium content aluminum-magnesium alloy comprising a ternary aluminum-scandium-zirconium phase and consisting essentially of:

5 to 6% by weight magnesium (Mg);

0.05 to 0.15% by weight zirconium (Zr);

0.05 to 0.12% by weight manganese (Mn);

0.01 to 0.2% by weight titanium (Ti);

0.05 to 0.5% total by weight of scandium (Sc), terbium (Tb), and optionally at least one additional element which is a lanthanide, wherein scandium (Sc) and terbium (Tb) are present as mandatory elements, with said terbium (Tb) replacing part of the scandium content such that the amount of terbium (Tb) is larger than the replaced part of the scandium content; and

at 0.1 to 0.2% by weight copper (Cu) or 0.1 to 0.4% by weight zinc (Zn), or both;

the balance being aluminum;

wherein unavoidable contaminants do not exceed 0.1% by weight silicon.

9. An aluminum-magnesium alloy as claimed in claim 8, wherein manganese (Mn) and scandium (Sc) are present in amounts to provide a ratio thereof of less than 2.

10. An aluminum-magnesium alloy as claimed in claim 8 or 9, wherein scandium is present in an amount of at least 0.15% by weight.

11. An aluminum-magnesium alloy as claimed in claim 8, 9 or 10, wherein said at least one additional element of the

lanthanide series is present in an amount of 0.05 to 0.35% by weight.

12. An aluminum-magnesium alloy as claimed in claim 11, wherein said lanthanide series element is cerium (Ce), neodymium (Nd), europium (Eu), gadolinium (Gd), dysprosium (Dy), holmium (Ho) or erbium (Eb).

13. A welded component of an aircraft consisting of an alloy as defined in any one of claims 8 to 12.