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(54) **AL-CU-LI-MG-MN-ZN ALLOY WROUGHT PRODUCT**

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(57) **ABSTRACT**

An aluminium alloy wrought product for structural members having a chemical composition of, in wt. %: Cu 3.2% to 4.4%, Li 0.8% to 1.4%, Mg 0.20% to 0.90%, Mn 0.10% to 0.8%, Zn 0.20% to 0.80%, one or more elements selected from the group of: (Zr 0.05% to 0.25%, Cr 0.05% to 0.30%, Ti 0.01% to 0.25%, Sc 0.05% to 0.4%, Hf 0.05% to 0.4%), Ag<0.08%, Fe<0.15%, Si<0.15%, unavoidable impurities and balance aluminium.

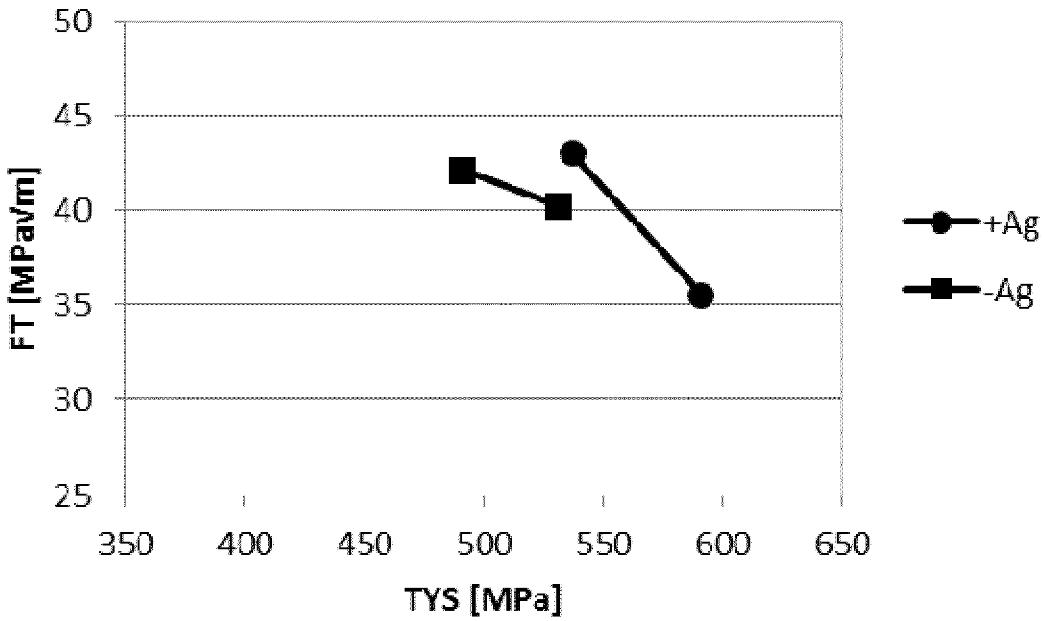


Fig. 1

# AL-CU-LI-MG-MN-ZN ALLOY WROUGHT PRODUCT

## FIELD OF THE INVENTION

[0001] The invention relates to an Al—Cu—Li wrought alloy product, more in particular an Al—Cu—Li—Mg—Mn—Zn type alloy product for structural members. Products made from this aluminium alloy product are very suitable for aerospace applications, but not limited to that. The alloy can be processed to various product forms, e.g. sheet, thin plate, thick plate, extruded or forged products.

## BACKGROUND TO THE INVENTION

[0002] It is generally known in the aerospace industry that one of the most effective ways to reduce the weight of an aircraft is to reduce the density of aluminium alloys used in the aircraft construction. This desire led to the addition of lithium, the lowest density metal element, to aluminium alloys. Aluminium Association alloys, such as AA2090 and AA2091 contain about 2.0% lithium, which translates into about a 7% weight savings over alloys containing no lithium. Aluminium alloys AA2094 and AA2095 contain about 1.2% lithium. Another aluminium alloy, AA8090 contains about 2.5% lithium, which translates into an almost 10% weight savings over alloys without lithium.

[0003] However, casting of such conventional alloys containing relatively high amounts of lithium is difficult. Furthermore, the combined strength and fracture toughness of such alloys is not optimal. A trade-off exists with conventional aluminium-lithium alloys in which fracture toughness decreases with increasing strength. Another important characteristic of aerospace aluminium alloys is fatigue crack growth resistance. For example, in damage tolerant applications in aircraft, increased fatigue crack growth resistance is desirable. Better fatigue crack growth resistance means that cracks will grow slower, thus making airplanes much safer because small cracks can be detected before they achieve critical size for catastrophic propagation. Furthermore, slower crack growth can have an economic benefit due to the fact that longer inspection intervals can be utilized.

[0004] Patent document US-2004/0071586 discloses a broad range for an aluminium alloy comprising, 3 to 5% of Cu, 0.5% to 2% of Mg, and 0.01% to 0.9% of Li. It is disclosed that the Li content should remain at a low level in combination with having controlled amounts of Cu and Mg to provide the desired levels of fracture toughness and strength. Preferably the Cu and Mg are present in the alloy in a total amount below a solubility limit of the alloy. It is known in the art that this patent document covers the AA2060 alloy being registered with in Aluminium Association in 2011 and having a registered alloy composition of:

| | |
|---|---|
| Cu | 3.4-4.5 |
| Li | 0.6-0.9 |
| Mg | 0.6-1.1 |
| Ag | 0.05-0.50 |
| Zn | 0.30 0.50 |
| Mn | 0.10-0.50 |
| Zr | 0.05-0.15. |

[0005] Patent document WO-2004/106570 discloses an Al—Cu—Li—Mg—Ag—Mn—Zr alloy for use as a structural member. The alloy has 2.5% to 5.5% Cu, 0.1% to 2.5% Li, 0.2% to 1% Mg, 0.2% to 0.8% Ag, 0.2% to 0.8% Mn, and up to 0.3% Zr, balance aluminium. It is known in the art that this patent document covers the AA2050 alloy being registered with in Aluminium Association in 2004 and having a registered alloy composition of:

| | |
|---|---|
| Cu | 3.2-3.9 |
| Li | 0.7-1.3 |
| Mg | 0.20-0.6 |
| Ag | 0.20-0.7 |
| Mn | 0.20-0.50 |
| Zr | 0.06-0.14. |

[0006] Patent document US-2007/0181229 discloses an aluminium alloy having 2.1% to 2.8% Cu, 1.1% to 1.7% Li, 0.1% to 0.8% Ag, 0.2% to 0.6% Mg, 0.2% to 0.6% Mn, a content of Fe and Si less or equal to 0.1% each, balance impurities and aluminium, and wherein the alloy is substantially zirconium free. The low Zr content is reported to increase the toughness.

[0007] Patent document WO-2009/036953 discloses an Al—Cu—Li—Mg—Ag—Zn—Mn—Zr alloy for use as an aircraft structural member. The alloy has Cu 3.4% to 5.0%, Li 0.9% to 1.7%, Mg 0.2% to 0.8%, Ag 0.1% to 0.8%, Mn 0.1% to 0.9%, Zn max. 1.5%, one or more elements selected from the group (Zr, Cr, Ti, Sc, Hf).

[0008] Patent document WO-2009/073794 discloses an Al—Cu—Li—Mg—Ag—Zn—Mn—Zr alloy for use as an aircraft structural member. The alloy has Cu 3.4% to 4.2%, Li 0.9% to 1.4%, Ag 0.3% to 0.7%, Mg 0.1% to 0.6%, Zn 0.2% to 0.8%, Mn 0.1% to 0.6%, and 0.01% to 0.6% of a grain structure control element. It is known in the art that this patent document covers the AA2050 alloy being registered with in Aluminium Association in 2012 and having a registered alloy composition of:

| | |
|---|---|
| Cu | 3.2-4.2 |
| Li | 1.0-1.3 |
| Mg | 0.20-0.6 |
| Zn | 0.30-0.7 |
| Ag | 0.20-0.7 |
| Mn | 0.10-0.50 |
| Zr | 0.05-0.15. |

[0009] Patent document WO2015/082779 discloses an Al-Ci-Li alloy product is the form of an rolled or forged product having a thickness of 14 to 100 mm, and wherein the alloy has 1.8% to 2.6% Cu, 1.3% to 1.8% Li, 0.1% to 0.5% Mg, 0.1% to 0.5% Mn with Zr<0.05%, or <0.05% Mn with 0.10% to 0.16% Zr, 0 to 0.5% Ag, <0.20% Zn, 0.01% to 0.15% Ti, <0.1% Fe, <0.1% Si. The material is in particular suitable for manufacturing airplane underwing elements.

[0010] A need exists for an aluminium alloy that is useful in aircraft application which has an improved thermal stability while providing a good balance in strength and fracture toughness.

## DESCRIPTION OF THE INVENTION

[0011] As will be appreciated herein below, except as otherwise indicated, alloy designations and temper designations refer to the Aluminium Association designations in Aluminium Standards and Data and the Registration

Records, as published by the Aluminium Association in 2015 and known to the skilled person.

**[0012]** For any description of alloy compositions or preferred alloy compositions, all references to percentages are by weight percent unless otherwise indicated.

**[0013]** As used herein, the term "about" when used to describe a compositional range or amount of an alloying addition means that the actual amount of the alloying addition may vary from the nominal intended amount due to factors such as standard processing variations as understood by those skilled in the art.

**[0014]** The term "up to" and "up to about", as employed herein, explicitly includes, but is not limited to, the possibility of zero weight-percent of the particular alloying component to which it refers. For example, up to 0.07% Fe may include an alloy having no Fe.

**[0015]** It is an object of the present invention to provide an improved AlCuLi-type alloy wrought product, or at least an alternative product, ideally for structural members, having a good balance of high strength and fracture toughness and providing an increased thermal stability.

**[0016]** These and other objects and further advantages are met or exceeded by the present invention in which there is provided an aluminium alloy wrought product for structural members having a chemical composition consisting of, in wt. %: Cu 3.2% to 4.4%, Li 0.8% to 1.4%, Mg 0.20% to 0.90%, Mn 0.10% to 0.8%, Zn 0.20% to 0.80%, one or more elements selected from the group consisting of: (Zr 0.05% to 0.25%, Cr 0.05% to 0.30%, Ti 0.01% to 0.25%, Sc 0.05% to 0.4%, Hf 0.05% to 0.4%), Ag<0.08%, Fe<0.15%, Si<0.15%, unavoidable impurities and balance aluminium.

**[0017]** The alloy wrought product may contain normal and inevitable impurities, typically each <0.05% and the total <0.15%, and the balance is made by aluminium.

**[0018]** In accordance with the invention it has been found that this compositional range, and with preferred narrower ranges, offers a good balance of strength, fracture toughness and corrosion resistance meeting the requirements for commercial delivery and also offering a very good thermal stability after being long term aged or exposed for 1000 hours at 85° C. These advantages are achieved at least in a T8 condition and by selecting the alloying elements within the defined ranges and wherein it is an important aspect that the subject alloy has a very low silver content.

**[0019]** Copper is one of the main alloying elements in the alloy product and is added to increase the strength of the alloy product. Care must be taken, however, to not add too much copper since the corrosion resistance can be reduced. Also, copper additions beyond maximum solubility will lead to low fracture toughness and low damage tolerance. The upper-limit for the Cu-content is for that reason about 4.4%, and preferably about 4.2%, and more preferably about 4.10%. A preferred lower-limit is about 3.6%, and more preferably about 3.75%, and most preferably about 3.85%.

**[0020]** Magnesium is another main alloying element in the alloy product and is added to increase strength and reduce density. Care should be taken, however, to not add too much magnesium in combination with copper since additions beyond maximum solubility will lead to low fracture toughness and low damage tolerance. A more preferred lower-limit for the Mg addition is about 0.35%, more preferably 0.38%. A more preferred upper-limit is about 0.65%, and more preferably 0.55%. It has been found that at a level of above 0.8% the further addition of Mg may result in a decrease in toughness of the alloy product.

**[0021]** Lithium is another important alloying element in the wrought product of this invention and added together with the copper and magnesium to obtain an improved combination of fracture toughness and strength. A preferred lower-limit for the Li addition is 0.9%, and more preferably 1.0%. A preferred upper-limit for the Li addition is less than 1.30%. A too high Li content has adverse effect on the damage tolerance properties of the alloy product in particular with the relatively high Cu levels in the alloy product of this invention.

**[0022]** The zinc is purposively added to improve strength and the corrosion resistance and in addition it has a small effect on the damage tolerance properties of the alloy product. In the alloy product the zinc is typically present in a range of about 0.2% to 0.80%. A preferred lower-limit for the Zn-content is 0.25%. A preferred upper-limit for the Zn-content is about 0.70%, and more preferably about 0.65%.

**[0023]** It is an important aspect of the invention that the silver content is less than about 0.08% and preferably less than about 0.05%. In an embodiment the silver content is less than about 0.02%, such that the aluminium alloy is substantially free from Ag. With "substantially free" or "essentially free" is meant that no purposeful addition was made to the chemical composition but that due to impurities and/or leaking from contact with manufacturing equipment, trace quantities of Ag may nevertheless find their way into the alloy product. For example, less than 0.01% is an example of a trace quantity. That the alloy product has a very low Ag content makes the alloy product more cost effective in comparison to the many Al—Cu—Li alloy known in the art having a purposive addition of Ag, while still offering a good balance of engineering properties in combination with a very good thermal stability.

**[0024]** The manganese addition is to control the grain structure by providing a more uniform distribution of the main precipitating phases, a reduced grain size and thereby further increases strength in particular. The Mn addition should not exceed about 0.8% and should be at least about 0.10%. A preferred lower-limit for the manganese addition is at least about 0.20%, and more preferably at least 0.30%. A preferred upper-limit for the Mn addition is about 0.6%, and more preferably about 0.55%. A too high Mn content results in a decrease in both the yield strength and fracture toughness.

**[0025]** In addition the alloy product of the present invention contains at least one element selected from the defined group of Zr, Cr, Ti, Sc, and Hf.

**[0026]** It is preferred to add zirconium to the alloy product in a range of 0.05% to 0.25%, and preferably in a range of 0.05% to 0.15%. A too low Zr addition has an adverse on the unit propagation energy of the alloy wrought product.

**[0027]** Ti can be added to the alloy product amongst others for grain refiner purposes during casting of the alloy stock, e.g. ingots or billets. The addition of Ti should not exceed 0.25%. A preferred lower limit for the Ti addition is about 0.01%. Ti can be added as a sole element or with either boron or carbon serving as a casting aid, for grain size control.

**[0028]** The Si content in the alloy product is present as an impurity element of less than 0.15%, and should be present at the lower-end of this range, e.g. less than about 0.10%, and more preferably less than 0.07%, to maintain fracture toughness properties at desired levels.

[0029] The Fe content in the alloy product should be less than 0.15%. When the alloy product is used for aerospace application the lower-end of this range is preferred, e.g. less than about 0.1%, and more preferably less than about 0.07% to maintain in particular the toughness at a sufficiently high level. Where the alloy product is used for non-aerospace applications, such as tooling plate, a higher Fe content can be tolerated.

[0030] In an embodiment of the alloy product the product is in the form of a rolled, extruded or forged product, and more preferably the product is in the form of a sheet, plate, forging or extrusion as part of an aircraft structural part.

[0031] In a preferred embodiment the alloy product is provided in the form of an extruded product.

[0032] In a preferred embodiment the alloy product is provided in the form of a plate product, preferably having a thickness of 12.0 to 175 mm, and preferably of at least 75 mm. The plate product provides a good balance in engineering properties, in particular strength and has shown reduced quench sensitivity.

[0033] When used as part of an aircraft structural part the part can be for example a fuselage sheet, upper wing plate, lower wing plate, thick plate for machined parts, forging or thin sheet for stringers.

[0034] Resistance to intergranular corrosion of the alloy products of the present invention is generally high, for example, typically only pitting is detected when the metal is submitted to corrosion testing according to MASTMAASIS (ASTM-69 A2-85). However, the sheet and light gauge plate may also be clad, with preferred cladding thickness of from about 1% to about 8% of the thickness of the sheet or plate. The cladding is typically a low composition aluminium alloy.

[0035] In a further aspect of the invention it relates to a method of manufacturing a wrought aluminium alloy product of an Al—Cu—Li alloy, the method comprising the steps of:

[0036] a. casting stock of an ingot of an AlCuLi-alloy according to this invention,

[0037] b. preheating and/or homogenizing the cast stock;

[0038] c. hot working the stock by one or more methods selected from the group consisting of rolling, extrusion, and forging;

[0039] d. optionally cold working the hot worked stock;

[0040] e. solution heat treating (“SHT”) of the hot worked and/or optionally cold worked stock, the SHT is carried out at a temperature and time sufficient to place into solid solution the soluble constituents in the aluminium alloy;

[0041] f. cooling the SHT stock, preferably by one of spray quenching or immersion quenching in water or other quenching media;

[0042] g. optionally stretching or compressing the cooled SHT stock or otherwise cold working the cooled SHT stock to relieve stresses, for example levelling or drawing or cold rolling of the cooled SHT stock; and

[0043] h. ageing, preferably artificial ageing, of the cooled and optionally stretched or compressed or otherwise cold worked SHT stock to achieve a desired temper.

[0044] The aluminium alloy can be provided as an ingot or slab or billet for fabrication into a suitable wrought product by casting techniques regular in the art for cast products, e.g. DC-casting, EMC-casting, EMS-casting. Slabs resulting from continuous casting, e.g. belt casters or roll casters, also may be used, which in particular may be advantageous when producing thinner gauge end products. Grain refiners such as those containing titanium and boron, or titanium and carbon, may also be used as is known in the art. After casting the alloy stock, the ingot is commonly scalped to remove segregation zones near the cast surface of the ingot.

[0045] Homogenisation treatment is typically carried out in one or multiple steps, each step having a temperature in the range of about 475° C. to 535° C. The pre-heat temperature involves heating the hot working stock to the hot-working entry temperature, which is typically in a temperature range of about 440° C. to 490° C.

[0046] Following the preheat and/or homogenisation practice the stock can be hot worked by one or more methods selected from the group consisting of rolling, extrusion, and forging, preferably using regular industry practice. The method of hot rolling is preferred for the present invention.

[0047] The hot working, and hot rolling in particular, may be performed to a final gauge, e.g. 3 mm or less or alternatively thick gauge products. Alternatively, the hot working step can be performed to provide stock at intermediate gauge, typical sheet or thin plate. Thereafter, this stock at intermediate gauge can be cold worked, e.g. by means of rolling, to a final gauge. Depending on the alloy composition and the amount of cold work an intermediate anneal may be used before or during the cold working operation.

[0048] Solution heat-treatment (“SHT”) is typically carried out within the same temperature range as used for homogenisation, although the soaking times that are chosen can be somewhat shorter. A typical SHT is carried out at a temperature of 480° C. to 525° C. for 15 min to about 5 hours. Lower SHT temperatures generally favour high fracture toughness. Following the SHT the stock is rapidly cooled or quenched, preferably by one of spray quenching or immersion quenching in water or other quenching media.

[0049] The SHT and quenched stock may be further cold worked, for example, by stretching in the range of about 0.5% to 15% of its original length to relieve residual stresses therein and to improve the flatness of the product. Preferably the stretching is in the range of about 0.5% to 6%, more preferably of about 0.5% to 4%.

[0050] After cooling the stock is aged, typically at ambient temperatures, and/or alternatively the stock can be artificially aged.

[0051] The alloy product according to this invention is preferably provided in a slightly under-aged T8 condition, in particular a T84 condition, to provide the best balance in strength and damage tolerance properties.

[0052] A desired structural shape is then machined from these heat treated plate sections, more often generally after artificial ageing, for example, an integral wing spar. SHT, quench, optional stress relief operations and artificial ageing are also followed in the manufacture of thick sections made by extrusion and/or forged processing steps.

[0053] In one embodiment of the present invention comprising a welding step, the ageing step can be divided into two steps: a pre-ageing step prior to a welding operation, and a final heat treatment to form a welded structural member.

[0054] The AlCuLi-alloy product according to this invention can be used amongst others as in the thickness range of at most 0.5 inch (12.5 mm) the properties will be excellent for fuselage sheet. In the thin plate thickness range of 0.7 to 3 inch (17.7 to 76 mm) the properties will be excellent for wing plate, e.g. lower wing plate. The thin plate thickness range can be used also for stringers or to form an integral wing panel and stringer for use in an aircraft wing structure. When processed to thicker gauges of more than 3 inch (75 mm) to about 11 inch (280 mm) excellent properties have been obtained for integral part machined from plates, or to form an integral spar for use in an aircraft wing structure, or in the form of a rib for use in an aircraft wing structure. The alloy products according to the invention can also be provided in the form of a stepped extrusion or extruded spar or extruded stiffeners for use in an aircraft structure, or in the form of a forged spar for use in an aircraft wing structure.

**[0055]** When applied in the form of a sheet product the yield strength or proof strength of the product should be at least 460 MPa in the L-direction, and preferably at least 480 MPa. When applied in the form of an extruded product, e.g. as a stringer, or in the form of a plate product the yield strength or proof strength of the product should be at least 470 MPa in the L-direction, and more preferably at least 480 MPa. These strength levels can be obtained by a selecting the alloy composition within the claimed ranges, and preferably within the preferred narrower ranges, in combination with the artificial ageing practice to a T8 condition.

**[0056]** In the following, the invention will be explained by the following non-limitative example.

## EXAMPLE

**[0057]** On a laboratory scale 2 alloys have been cast and machined into rolling blocks of 260×200×80 mm. The alloy compositions are given in Table 1. These were homogenised for 5 h@500° C. followed by 10 h@510° C. After preheating to 480° C. the rolling blocks were hot rolled from 80 mm to a gauge of 30 mm. Then solution heat-treated for 30 min@500° C. followed by a cold water quench and within 30 minutes thereafter stretched by 2%.

TABLE 1

Alloy composition (in wt. %) of the alloys processed. Balance is made by aluminium and unavoidable impurities and with 0.03% Fe and 0.02% Si.

| | Alloying element | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Alloy | Cu | Li | Mg | Mn | Zn | Zr | Ti | Ag |
| A | 3.9 | 1.1 | 0.4 | 0.4 | 0.4 | 0.11 | 0.02 | 0.35 |
| B | 3.9 | 1.1 | 0.4 | 0.4 | 0.4 | 0.11 | 0.02 | 0.0 |

**[0058]** In order to bring the alloy to a T84 temper the Ag-free alloy was aged for 16 h@150° C. and the Ag containing alloy for 10.5 h@150° C. The difference in ageing time to arrive at the T84 temper is due to the difference in silver-content which has an effect on the ageing response.

**[0059]** In order to test the thermal stability the samples in T84 were subsequently sensitized or aged for 1,000 h@85° C.

**[0060]** The materials in the T84 condition and after 1000 h@85° C. were tested for the tensile yield strength (TYS) in the L-direction in accordance with ASTM B557M and for the fracture toughness ($K_{IC}$) in the L-T direction in accordance with ASTM E399. The results are listed in Table 2 below. The results of Table 2 are also plotted in FIG. **1**.

**[0061]** In addition the samples aged after 1000 h@85° C. were tested for their corrosion resistance in accordance with MASTMAASIS and SCC(ST). All ST-SCC specimens tested at 310 MPa survived without failure for 30 days.

**[0062]** From the results of Table 2 and FIG. **1** it can be seen that the Ag-free alloy B compared to alloy A provides a significantly lower drop in fracture toughness after being sensitized while maintaining a high tensile yield strength in combination with a good corrosion resistance. This suggests that alloy B provides an improved thermal stability than the similar alloy containing also a purposive addition of silver.

TABLE 2

Mechanical properties in T84 condition and after sensitization for 1,000 h@85° C.

| Alloy | Condition | TYS (L) [MPa] | $K_{IC}$ [MPa · Vm] |
|---|---|---|---|
| A | T84 | 537 | 43.0 |
| A | sensitized | 591 | 35.5 |
| B | T84 | 491 | 41.1 |
| B | sensitized | 531 | 40.2 |

**[0063]** Having now fully described the invention, it will be apparent to one of ordinary skill in the art that many changes and modifications can be made without departing from the spirit or scope of the invention as herein described.

**1**. An aluminium alloy wrought product for structural members having a chemical composition consisting of, in wt. %:

| | |
|---|---|
| Cu | 3.2 to 4.4 |
| Li | 0.8 to 1.4 |
| Mg | 0.20 to 0.90 |
| Mn | 0.10 to 0.8 |
| Zn | 0.20 to 0.80, |

one or more elements selected from the group consisting of:

| | |
|---|---|
| Zr | 0.05 to 0.25, |
| Cr | 0.05 to 0.30, |
| Ti | 0.01 to 0.25, |
| Sc | 0.05 to 0.4, |
| Hf | 0.05 to 0.4, |
| Ag | <0.08 |
| Fe | <0.15 |
| Si | <0.15, |

unavoidable impurities and balance aluminium.

**2**. An aluminium alloy wrought product according to claim **1**, wherein the Cu content is in a range of 3.6% to 4.4%.

**3**. An aluminium alloy wrought product according to claim **1**, wherein the Li content is in a range of 0.90% to 1.4%.

**4**. An aluminium alloy wrought product according to claim **1**, wherein the product contains Zr in a range of 0.05% to 0.15%.

**5**. An aluminium alloy wrought product according to claim **1**, wherein the Zn-content is maximum 0.70%.

**6**. An aluminium alloy wrought product according to claim **1**, wherein the Ag content is less than 0.05%.

**7**. An aluminium alloy wrought product according to claim **1**, wherein the product contains Mn in a range of 0.20% to 0.6%.

8. An aluminium alloy wrought product according to claim 1, wherein the product contains Mg in a range of 0.20% to 0.8%.

9. An aluminium alloy wrought product according to claim 1, wherein the product is in the form of a rolled, extruded or forged product.

10. An aluminium alloy wrought product according to claim 9, wherein the wrought product is in the form of an extruded product.

11. An aluminium alloy wrought product according to claim 1, wherein the wrought product is in the form of a plate product having a thickness of 12.0 mm to 175 mm.

12. An aluminium alloy wrought product according to claim 9, wherein said wrought product has been treated with a hot deformation operation, a solution heat-treatment followed by quenching, and artificial ageing.

13. An aluminium alloy wrought product according to claim 9, wherein said wrought product has been treated with a solution heat-treatment followed by quenching, cold strain-hardening, and possesses a permanent deformation between 0.5% and 15%.

14. An aluminium alloy wrought product according to claim 1, wherein the product is in an under-aged T8 condition.

15. The method of manufacturing an aluminium alloy wrought product according to claim 1, comprising the steps of:

a. casting stock of an ingot of an AlCuLi-alloy according to claim 1,
b. preheating and/or homogenizing the cast stock;
c. hot working the stock by one or more methods selected from the group consisting of rolling, extrusion, and forging;
d. optionally cold working the hot worked stock;
e. solution heat treating (SHT) of the hot worked and/or optionally cold worked stock, the SHT is carried out at a temperature and time sufficient to place into solid solution the soluble constituents in the aluminium alloy;
f. cooling the SHT stock;
g. optionally stretching or compressing the cooled SHT stock or otherwise cold working the cooled SHT stock to relieve stresses; and
h. ageing, preferably artificial ageing, of the cooled and optionally stretched or compressed or otherwise cold worked SHT stock to achieve a desired temper.

16. The method according to claim 15, wherein homogenisation is performed at a temperature in a range of 475° C. to 535° C.

17. The method according to claim 15, wherein the hot-working is by rolling and the hot-working entry temperature is at a temperature in the range of 440° C. to 490° C.

18. The method according to claim 15, wherein the solution heat treatment is performed at a temperature in a range of 480° C. to 525° C.

19. The method according to claim 15, wherein the stretching is per-formed in a range of 0.5% to 6%.

20. The method according to claim 15, wherein the product has been aged to an under-aged T8 condition.

21. The method according to claim 15, wherein the wrought product is rolled to a plate product having a thickness of at least 12.0 mm.

22. An aluminium alloy wrought product according to claim 1, wherein the Cu content is in a range of 3.75% to 4.20%.

23. An aluminium alloy wrought product according to claim 1, wherein the Li content is in a range of 1.0% to 1.30%.

24. An aluminium alloy wrought product according to claim 1, wherein the alloy product is substantially Ag-free.

25. An aluminium alloy wrought product according to claim 1, wherein the product contains Mn in a range of 0.20% to 0.55%.

26. An aluminium alloy wrought product according to claim 1, wherein the product contains Mg in a range of 0.20% to 0.65%.

27. An aluminium alloy wrought product according to claim 1, wherein the product contains Mg in a range of 0.35% to 0.65%.

28. An aluminium alloy wrought product according to claim 9, wherein said wrought product has been treated with a solution heat-treatment followed by quenching, cold strain-hardening, and possesses a permanent deformation between 0.5% and 6%.

29. The method according to claim 15, wherein otherwise cold working the cooled SHT stock to relieve stresses one or more of levelling or drawing or cold rolling of the cooled SHT stock

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