HIGH STRENGTH, CREEP RESISTANT ZINC ALLOY

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ABSTRACT
Provided are high strength, creep resistant zinc alloys with superior mechanical and other properties.
Creep Performance (140 C & 31 MPa)

FIG. 3

Yield Strength

FIG. 4
**Hardness**

![Hardness Bar Chart](image)

**FIG. 5**

**Elongation**

![Elongation Bar Chart](image)

**FIG. 6**
<table>
<thead>
<tr>
<th><strong>EZAC</strong></th>
<th><strong>ACuZinc 5</strong></th>
<th><strong>Zamak 2</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Phase is Epsilon (Cu Rich) - Surrounded by Ternary Eutectic Matrix (Epsilon, Eta, Alpha). Note the Size Difference in Epsilon Phase Compared to ACuZinc. This is Because the EZAC is Closer to the Ternary Eutectic Region.</td>
<td>Primary Phase is Epsilon - Surrounded by Ternary Eutectic Matrix.</td>
<td>Primary Phase is Eta (Zinc Rich) Surrounded by a Binary Eutectic Matrix of Eta and Epsilon. Also Signs of Epsilon.</td>
</tr>
</tbody>
</table>

**FIG. 7**
Average Secondary Creep Performance

FIG. 8

Time to 1% Creep

FIG. 9
Combined Stress Strain Curves

<table>
<thead>
<tr>
<th></th>
<th>Stress (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EZAC</td>
<td>500</td>
</tr>
<tr>
<td>ACuZinc 5</td>
<td>400</td>
</tr>
<tr>
<td>Zamak 2</td>
<td>300</td>
</tr>
</tbody>
</table>

Strain (%)

FIG. 10

Ultimate Tensile Strength

<table>
<thead>
<tr>
<th>Zinc Alloys</th>
<th>Strength (ksi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZAMAK 3</td>
<td>40</td>
</tr>
<tr>
<td>ZAMAK 5</td>
<td>50</td>
</tr>
<tr>
<td>ZA-8</td>
<td>60</td>
</tr>
<tr>
<td>ACuZinc5</td>
<td>70</td>
</tr>
<tr>
<td>ZA-12</td>
<td>80</td>
</tr>
<tr>
<td>ZA-27</td>
<td>90</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other Die Casting Alloys</th>
<th>Strength (ksi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A380</td>
<td>10</td>
</tr>
<tr>
<td>AZ-91D</td>
<td>20</td>
</tr>
</tbody>
</table>

FIG. 11
Stress Strain Curve at 212 F

FIG. 12

High Temperature Tensile Strength (212 F)

FIG. 13
HIGH STRENGTH, CREEP RESISTANT ZINC ALLOY

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application No. 61/271,421, filed Jul. 20, 2009, and is a continuation in part of U.S. patent application Ser. No. 12/568,390, filed on Sep. 28, 2009, which also claims benefit of U.S. Provisional Patent Application No. 61/271,421, filed Jul. 20, 2009. These applications are hereby incorporated by reference in their entireties.

BACKGROUND OF THE INVENTION

[0002] Zinc alloys are used in the die casting industry for high volume, net shaped components. Many commercial zinc alloys also have a relatively low melting point, high fluidity, and low attack rate on shot end components which allows for low cost advantages over other processes and materials. There are several commercial zinc die casting alloys that are commercially available. The following table lists these alloys, with their respective compositions (based on die-casting).”

<table>
<thead>
<tr>
<th>Alloy</th>
<th>Zine %</th>
<th>Cu %</th>
<th>Mg %</th>
<th>Ni %</th>
<th>Be %</th>
<th>Ti %</th>
<th>Cr %</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZA7-3</td>
<td>7.6-8.0</td>
<td>3.0-3.3</td>
<td>0.02-0.03</td>
<td>0.02-0.05</td>
<td>0.08-0.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZA1-9</td>
<td>7.6-8.0</td>
<td>3.0-3.3</td>
<td>0.02-0.03</td>
<td>0.02-0.05</td>
<td>0.08-0.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACuZinc</td>
<td>3.0-4.0</td>
<td>10.0-11.0</td>
<td>0.025-0.05</td>
<td>0.025-0.05</td>
<td>0.025-0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superloy</td>
<td>6.6-7.2</td>
<td>3.0-3.6</td>
<td>0.03-0.06</td>
<td>0.02-0.06</td>
<td>0.08-0.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beric</td>
<td>3.5-4.0</td>
<td>3.2-3.7</td>
<td>0.03-0.06</td>
<td>0.02-0.06</td>
<td>0.08-0.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZA6-3</td>
<td>7.6-8.0</td>
<td>3.0-3.3</td>
<td>0.02-0.03</td>
<td>0.02-0.05</td>
<td>0.08-0.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(project)</td>
<td>7.26</td>
<td>2.85</td>
<td>0.167</td>
<td>0.094</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[0003] ACuZinc is disclosed in U.S. Pat. No. 4,990,310, incorporated herein by reference in its entirety.

[0004] One disadvantage of zinc based alloys (in part) due to the lower melting temperature is creep resistance, or long term deformation due to moderate stress at higher temperatures.

[0005] U.S. Pat. No. 4,990,310 claims a “A creep resistant zinc-base die casting consisting essentially of, by weight, between about 4 and 12 percent copper, 2 and 4 percent aluminum, up to 0.05 percent magnesium and the balance zinc and impurities, said die casting having fine epsilon and eta grains dispersed in a ternary eutectic matrix and exhibiting a creep strain at 150°C, subjected to a 40 MPa load of less than 2 percent after more than 70 hours.”

[0006] The International Lead Zinc Research Organization (ILZRO) developed a program called ZCA-9 to find a zinc based alloy that has improved creep resistance. The creep test is performed with tensile samples at 31 MPa & 140°C.

[0007] The result of the research shows one alloy with improved creep performance. For example, ZA-8 failed the accelerated creep test at 3-4 hours, while alloy designated #16 failed at 160 hours. At the completion of the research, alloy #16 had the best creep performance. The researchers assumed that the reason for the improved creep performance is due to the ternary eutectic composition of Epsilon (copper rich), Eta (zinc rich), and Alpha (aluminum rich).

[0008] In addition to creep performance, a zinc alloy needs to exhibit other desired characteristics, including high tensile strength, high yield strength, and hardness.

[0009] An alloy should also be easy to cast for commercial purposes. It is preferred to cast a zinc alloy about 50°F above its liquidus temperature. Because of this 50°F preference, an alloy with a lower liquidus temperature makes casting easier by making it possible to raise the temperature 50°F above its liquidus temperature.

[0010] There is a need for a superior zinc alloy having suitable creep, strength and hardness characteristics, and be easy to cast.

SUMMARY OF THE INVENTION

[0011] In one embodiment the present invention provides a zinc alloy comprising about 4% to about 8% Al (or about 5% to about 8% Al), and about 3% to about 9% Cu, wt/wt., with the rest essentially Zinc, wt/wt. The Al and Cu content can be:

- about 4% Al (or about 5% Al), and about 3% to about 6 wt/wt Cu, wt/wt;
- about 7% to about 8% Al and about 5% to 9% Cu, wt/wt;
- about 6% to about 7% Al, and about 5% to about 7% Cu, wt/wt;
- about 6% to about 7% Al, and about 5% to about 7% Cu, wt/wt;
- about 4% to about 5% Al, and about 3% to about 6 wt/wt Cu, wt/wt;
- about 6% to about 8% Al and about 5% to about 6% Cu, wt/wt;
- about 6.4% to about 6.8% Al and about 5.2% to about 5.7% Cu, wt/wt;
- about 6.6% Al and about 5.5% Cu, wt/wt.

[0012] In one embodiment the present invention provides a zinc alloy comprising Cu relative to Al in a ratio of about 1 to about 0.74 Cu to Al or of about 1 to about 0.85 Cu to Al, or about 1 to about 0.90 wt/wt. The ratio can also be about 0.95 to about 0.98.

In one embodiment, the range is about 3.9% to about 8.3% by weight Al and about 4.1% to about 6.5% by weight Cu. In a preferred embodiment, the range is about 5.3 to about 7.3% by weight Al and about 4.2% to about 6.5% by weight Cu.

In one embodiment the present invention provides a zinc alloy consisting essentially of any of the Cu and Al percentages described above, with the rest essentially zinc.

In one embodiment the present invention provides a zinc alloy consisting of any of the Cu and Al percentages described above, with the rest essentially zinc.

In one embodiment the present invention provides a zinc alloy with any of the Cu and Al percentages described,...
above, further comprising one or more of magnesium of about 0.025 to about 0.05 wt/wt, chromium in amounts up to 0.2% wt/wt, titanium up to about 0.3% wt/wt.

[0024] In one embodiment the present invention provides a zinc alloy with any of the Cu and Al percentages described above, and one or more of incidental impurities, such as non-limiting examples of lead to a maximum of about 0.005%, cadmium to a maximum of about 0.004%, tin to a maximum of about 0.003%, and iron to a maximum of about 0.1%.

[0025] In one embodiment the present invention provides a zinc alloy with any of the Cu and Al percentages described above having a creep resistance of more than about 100 hours, more preferably more than about 300 hours, about 250 to about 850, about 400 to about 850, about 500 to about 850, about 600 to about 850 hours, about 700 to 850 hours. Creep resistance is measured at 140°C, 31 MPa, and is based on a testing run to completion (final rupture) and a using a cylindrical die cast sample (shown in FIG. 3).

[0026] In one embodiment the present invention provides a zinc alloy with any of the Cu and Al percentages described above (including one or more of the above creep resistance data) having a hardness of about 63 to about 70, more preferably about 65 to about 70, when measured with a 100K load with Rockwell B.

[0027] In one embodiment the present invention provides a zinc alloy with any of the Cu and Al percentages described above (including one or more of the above creep resistance and hardness data) having a yield strength at room temperature of about 345 MPa to about 414 MPa.

[0028] In one embodiment the present invention provides a zinc alloy with any of the Cu and Al percentages described above (including one or more of the above creep resistance, hardness, and yield strength) having a tensile strength at room temperature of about 345 MPa to about 414 MPa, or about 370 to about 414, MPa. (Kilopounds per square inch).

[0029] In one embodiment the present invention provides a zinc alloy with any of the Cu and Al percentages described above (including one or more of the above creep resistance, yield strength, tensile strength, and elongation data) having a microstructure as depicted in top portion of FIG. 7.

[0030] In one embodiment the present invention provides an alloy (including one or more of the above mechanical properties) having ultimate tensile strength at 212°F of about 240 MPa to about 280 MPa, more preferably about 250 MPa to about 270 MPa.

[0031] In one embodiment the present invention provides an alloy (including one or more of the above mechanical properties) having a yield strength at 212°F of about 150 MPa to about 170 MPa.

[0032] In one embodiment the present invention provides a zinc alloy comprising about 4% to about 8% Al and about 3% to about 9% Cu, magnesium of about 0 to about 0.05 wt/wt, chromium of about 0 to about 0.2% wt/wt, titanium of about 0 to about 0.3% wt/wt, lead of about 0 to about 0.005%, cadmium of about 0 to about 0.004%, tin of about 0 to about 0.003%, iron of about 0 to about 0.1%, with the rest essentially Zn, wt/wt.

[0033] In one embodiment the present invention provides a process for preparing the zinc alloy of claim 1 in solid form comprising combining zinc, copper and aluminum with any optional additives to obtain a homogeneous liquid mixture, and cooling the mixture to solidify the mixture.

BRIEF DESCRIPTION OF THE FIGURES

[0034] FIG. 1 illustrates Cylindrical Sample used during Group 3 of testing & Flat Sample used during Groups 0-2, which are die cast samples.

[0035] FIG. 2 illustrates the ultimate tensile strength of different alloys.

[0036] FIG. 3 illustrates the creep performance of different alloys.

[0037] FIG. 4 illustrates the yield strength of different alloys. The data used in this graph is compiled from various sources. The data for Zamak 3, Zamak 5, ZA-8, ZA-12, ZA-27 are found in ASTM B86.

[0038] FIG. 5 illustrates the hardness of different alloys.

[0039] FIG. 6 illustrates the elongation of different alloys. The data used in this graph was compiled from various sources. The data for Zamak 3, Zamak 5, ZA-8, ZA-12, ZA-27 are found in ASTM B86.

[0040] FIG. 7 is micrographs of approximately 50-100x of the microstructure difference of different alloys.

[0041] FIG. 8 illustrates the average secondary creep performance. Testing parameters performed at 140°C and 31 MPa. These values are derived from the data that was used to plot the creep curves found in FIG. 3.

[0042] FIG. 9 illustrates the result of creep performance to 1% strain. Testing parameters performed at 140°C and 31 MPa. These values are derived from the data that was used to plot the creep curves found in FIG. 3.

[0043] FIG. 10 illustrates the stress strain test for three different alloys at room temperature based on die casting.

[0044] FIG. 11 illustrates the ultimate tensile strength of different alloys. The data used in this graph is compiled from various sources. The data for Zamak 3, Zamak 5, ZA-8, ZA-12, ZA-27 are found in ASTM B86.

[0045] FIG. 12 illustrates stress strain curve at 212°F. Stress strain curve at 212°F, graphed to 1.5% strain. This data shows that EZAC is stronger at higher temperature.

[0046] FIG. 13 illustrates high temperature tensile strength at 212°F. Resulting high temperature results comparing the UTS, yield and elongation results of various commercial alloys to EZAC.

DETAILED DESCRIPTION OF THE INVENTION

[0047] We have found out that by moving away from the ternary eutectic to the epsilon phase produces zinc alloys with superior properties, such as creep performance, tensile strength, yield strength and hardness, primarily due to the type and size of the phase formation. The alloy of the present invention can be easily cast. It has a liquidus temperature of approximately 800°F; it can even be as low about 742°F. A wide range for the liquidus temperature can be about 711 to about 842°F. This relatively low temperature allows casting this alloy without forming a solid phase.

[0048] The zinc alloy of the present invention comprises about 4% to about 8% Al (or about 5% to about 8% Al), and about 3% to about 9% Cu, wt/wt, with the rest essentially Zinc, wt/wt. The Al and Cu content can be about 4% Al (or about 5% Al), and about 3% to about 6% wt/wt Cu, wt/wt; about 7% to about 8% Al and about 5% to 9% Cu, wt/wt;
The zinc alloy can optionally include one or more additional elements. Magnesium can be added up to about 0.025 to about 0.05 wt/wt for corrosion protection. Chromium can be added in amounts of up to 0.2 wt/wt. Titanium can be added up to about 0.3% wt/wt.

Incidental impurities can also exist in the alloy. The impurities can be from impurities found in the starting materials or from the equipment used to make the alloy. Non-limiting examples of these impurities include lead to a maximum of 0.005%, Cadmium to a maximum of 0.004%, tin to a maximum of 0.003%, iron to a maximum of 0.1%, and combinations thereof.

The alloy of the present invention preferably has a creep resistance of more than about 100 or more than about 200 hours, more preferably more than about 300 hours. The creep resistance of the alloy can be about 200 to about 700, such as about 400 to about 700, or about 500 to about 700, or about 600 to about 700 hours. Creep resistance is measured at 140° C, 31 MPa, and is based on a testing run to completion (final rupture, based on a die cast cylindrical sample).

The alloy of the present invention preferably has a hardness of about 65 to about 70, more preferably about 65 to about 70, when measured with a 100K load with Rockwell B.

The alloy of the present invention preferably has a room temperature yield strength of about 345 to about 413 MPa.

The alloy of the present invention preferably has ultimate tensile strength at room temperature of about 276 MPa to about 414 MPa and most preferably about 345 MPa to about 414 MPa, or about 379 MPa to about 414 MPa.

The alloy of the present invention preferably has ultimate tensile strength at 212° F. of about 240 MPa to about 280 MPa, more preferably about 250 MPa to about 270 MPa.

The alloy of the present invention preferably has yield strength at 212° F. of about 150 MPa to about 170 MPa.

The microstructure of the zinc alloys of the present invention is provided in FIGS. 10 and 11. The zinc alloy of the present invention has a primary phase that is Epsilon (Cu rich), surrounded by ternary eutectic matrix (Epsilon, Eta, Alpha). There is a shape and size difference in Epsilon phase compared to Cu-Zinc probably because EZAC is closer to the ternary eutectic region.

The production of the zinc alloy of the present invention can be carried out by various techniques.

In one embodiment, a preliminary charge is added to the furnace that includes zinc, aluminum, copper, etc. Over time, as the charge melts, the balance of the charge is added to the furnace. It is common practice to use aluminum or zinc master alloys containing chromium and titanium to incorporate these elements into the composition. When essentially all of the components have melted and only a portion of aluminum or other higher melting material remains, the bath is mixed to complete the melting and dissolution and also to create a homogeneous blend. The mixing is preferably vigorous enough to draw the lighter components under and into the molten bath, but not so vigorous as to create excessive amounts of dross.

After sufficient mixing, the agitator can be slowed so that there is a slow rotation of the bath. At this time insoluble dross and intermetallic contaminants will begin to float to the surface of the bath. Enough time is preferably given to allow all of these contaminants to rise to the surface. The amount of time will vary with the size and shape of the furnace container. For example in a cauldron shaped pot of approximately 30,000 pound capacity, 15 to 30 minutes are generally sufficient.

After the allotted time, any floating dross is preferably removed using standard foundry practices. Several samples from varying depths can be taken and tested to ensure alloy composition and homogeneity. If required, additional components and/or mixing can be done until the alloy composition is in controlled limits.

The alloy of the present invention can be used in different casting processes, including sand casting and die casting. In addition to sand casting, other forms of gravity casting such as permanent mold casting can also be used. Spin casting (low pressure die casting) can also be used. It can also be in the form of an ingot. The creep characteristics of the alloy are provided based on a cylindrical die cast sample to be precise, but the alloy of the present invention can be in form of an ingot, die cast or sand cast.

For hot chamber die casting, the alloy of the present invention is preferably cast at a temperature about 400° C. to about 460° C. Higher temperatures can be used.

Ultimate Tensile Strength (UTS), Elongation, and Yield Strength can be tested with ASTM E-8. Hardness for Rockwell B can be tested with ASTM E-148. Creep Performance can be tested with ASTM E-139.

Comparative data for AcuZinc 5 can be found in ASTM B894. The ASTM specification for AcuZinc 5 pro-
vides UTS ranges of 310-355 MPa (51 ksi), yield ranges of 240-284 MPa (41 ksi), and elongation range of 4.6-9.4%.

Example 1

This example illustrates the composition of zinc alloys and their creep performance.

<table>
<thead>
<tr>
<th>TABLE 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creep Performance</td>
</tr>
<tr>
<td>Alloy</td>
</tr>
<tr>
<td>ZCA-9</td>
</tr>
<tr>
<td>Baseline - Zamak 5</td>
</tr>
<tr>
<td>Baseline - ZA-8</td>
</tr>
</tbody>
</table>

Creep Results—testing parameters of 140°C & 31 MPa—testing sample dimension changed. The following are the average of other properties of the alloys described in the above Table:

<table>
<thead>
<tr>
<th>TABLE 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield Strength (MPa)</td>
</tr>
<tr>
<td>Alloy</td>
</tr>
<tr>
<td>CuZinc</td>
</tr>
<tr>
<td>EZAC</td>
</tr>
<tr>
<td>EZAC-2</td>
</tr>
<tr>
<td>EZAC-3</td>
</tr>
<tr>
<td>Zamak 2</td>
</tr>
</tbody>
</table>

Table 5 has the chemical composition of the alloys that were tested and are illustrated in the figures:

<table>
<thead>
<tr>
<th>TABLE 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
</tr>
<tr>
<td>EZAC-1</td>
</tr>
<tr>
<td>EZAC-2</td>
</tr>
<tr>
<td>EZAC-3</td>
</tr>
<tr>
<td>Zamak 2</td>
</tr>
<tr>
<td>CuZinc</td>
</tr>
</tbody>
</table>

What is claimed is:

1. A zinc alloy comprising about 4% to about 8% Al and about 3% to about 9% Cu, optionally one or more additives, optionally one or more impurities, with the rest essentially Zinc, wt/wt.

2. The zinc alloy of claim 1, wherein the alloy has about 5% to about 8% Al, wt/wt.

[0072] Creep Results—testing parameters of 140°C, & 31 MPa—testing sample dimension changed. The following are the average of other properties of the alloys described in the above Table:

3. The zinc alloy of claim 1, wherein the alloy has about 4% Al to about 5% Al, and about 3% to about 6% Cu, wt/wt.

4. The zinc alloy of claim 1, wherein the alloy has about 7% to about 8% Al and about 5% to 9% Cu, wt/wt.

5. The zinc alloy of claim 1, wherein the alloy has about 6% to about 7% Al, and about 5% to about 7% Cu, wt/wt.

6. The zinc alloy of claim 1, wherein the alloy has about 6% to about 6.8% Al and about 6.5% to about 6% Cu, wt/wt.

7. The zinc alloy of claim 1, wherein the alloy has about 6.4% to about 6.8% Al and about 5.2% to about 5.7% Cu, wt/wt.

8. The zinc alloy of claim 1, wherein the alloy has about 6% to about 6.8% Al and about 5% to about 6% Cu, wt/wt.

9. The zinc alloy of claim 1, wherein the alloy has about 6.6% aluminum by weight and about 5.5% copper by weight.

10. The zinc alloy of claim 1, wherein Cu relative to Al is in a ratio of about 1:1 to about 0.74 Cu to Al.

11. The zinc alloy of claim 1, wherein Cu relative to Al is in a ratio of about 1:1 to about 0.85 Cu to Al.

12. The zinc alloy of claim 1, wherein the alloy has about 3.9% to about 8.3% by weight Al and about 4.1% to about 6.5% by weight Cu.

13. The zinc alloy of claim 1, wherein the alloy has about 5.3% to about 7.3% by weight Al and about 4.2% to about 6.5% by weight Cu.

14. The zinc alloy of claim 1, wherein the alloy comprises one or more of additives selected from the group consisting of...
magnesium of about 0.025 to about 0.05 wt/wt, chromium in amounts up to 0.2% wt/wt, and titanium up to about 0.3% wt/wt, and combinations thereof.

15. The zinc alloy of claim 1, wherein the alloy has one or more of incidental impurities.

16. The zinc alloy of claim 15, wherein the impurities are selected from the group consisting of at least one of lead to a maximum of about 0.005%, cadmium to a maximum of about 0.004%, tin to a maximum of about 0.003%, iron to a maximum of about 0.1%, and combinations thereof.

17. The zinc alloy of claim 1, wherein the alloy has a creep resistance of more than about 100 hours, at 140°C, 31 MPa, based on a testing run to completion (final rupture) with a cylindrical die cast sample.

18. The zinc alloy of claim 17, wherein the alloy has a creep resistance of more than about 300 hours.

19. The zinc alloy of claim 1, wherein the alloy has a hardness of about 63 to about 70, when measured with a 100K load with Rockwell B.

20. The zinc alloy of claim 1, wherein the alloy has a yield strength at room temperature of about 345 to about 414 MPa.

21. The zinc alloy of claim 1, wherein the alloy has an ultimate tensile strength at room temperature of about 345 to about 414 MPa.

22. The zinc alloy of claim 21, wherein the alloy has an ultimate tensile strength of about 379 to about 414 MPa.

23. The zinc alloy of claim 1, wherein the alloy has ultimate tensile strength at 212°F of about 240 to about 280 MPa.

24. The zinc alloy of claim 23, wherein the alloy has ultimate tensile strength at 212°F of about 250 to about 270 MPa.

25. The zinc alloy of claim 1, wherein the alloy has yield strength at 212°F of about 150 MPa to about 170 MPa.

26. The zinc alloy of claim 1, wherein the alloy has a primary phase that is Epsilon (Cu rich), surrounded by ternary eutectic matrix (Epsilon, Eta, Alpha).

27. The zinc alloy of claim 1, wherein the alloy has a microstructure as depicted in top portion of FIG. 7.

28. The zinc alloy of claim 1, wherein the alloy has a liquid temperature of about 711°F to about 842°F.

29. The zinc alloy of claim 1, wherein the alloy is in the form of a die cast, an ingot, or a gravity cast.

30. A zinc alloy comprising about 4% to about 8% Al and about 3% to about 9% Cu, magnesium of about 0 to about 0.05 wt/wt, chromium of about 0 to about 0.2% wt/wt, titanium of about 0 to about 0.3% wt/wt, lead of about 0 to about 0.005%, cadmium of about 0 to about 0.004%, tin of about 0 to about 0.003%, iron of about 0 to about 0.1%, with the rest essentially Zinc, wt/wt.

31. A process for preparing the zinc alloy of claim 1 in solid form comprising combining zinc, copper and aluminium with any optional additives to obtain a homogeneous liquid mixture, and cooling the mixture to solidify the mixture.

* * * * *