Select decorative article

100

Shape-cast decorative article from silicon-eutectic alloys

200

Finish decorative shape-cast article

300

FIG. 1

(Continued on next page)

(57) Abstract: The present application discloses decorative shape-cast articles including a silicon eutectic alloy. A decorative shape-cast article may have a body having at least one intended viewing surface. The body of the decorative shape-cast article includes at least one silicon eutectic alloy. The silicon eutectic alloy may include a eutectic aggregation of silicon and disilicides of a formula MS12, wherein M is a metallic element. The at least one intended viewing surface of the decorative shape-cast article comprises at least some of the silicon eutectic alloy. Examples of such decorative shape-cast articles include jewelry, tiles, facades, cases, plates, buttons, knobs, handles, faucets, and sconces, among others.

Declarations under Rule 4.17:
- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(i))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

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DECORATIVE SHAPE-CAST ARTICLES MADE FROM SILICON EUTECTIC ALLOYS, AND METHODS FOR PRODUCING THE SAME

BACKGROUND

[001] Silicon (Si) eutectic alloys can be fabricated by melting and casting processes (see, e.g., WO 201 1/022058). Such silicon eutectic alloys of WO201 1/022058 may realize improved fracture toughness.

SUMMARY OF THE DISCLOSURE

[002] Broadly, the present patent application relates to decorative shape-cast articles made from silicon eutectic alloys, and methods for producing the same. Such decorative shape-cast articles may find use as, for example, jewelry, tiles, facades, cases, plates, buttons, knobs, handles, faucets, and sconces, among others. Various definitions relating to the decorative shape-cast articles described herein are provided in the definitions section, below.

[003] In one embodiment, a decorative shape-cast article includes a body having at least one intended viewing surface. The body of the decorative shape-cast article may include a silicon eutectic alloy, and this silicon eutectic alloy comprises a eutectic aggregation of silicon and disilicides of a formula MSi_{2}, wherein M is a metallic element, described below. The at least one intended viewing surface of the decorative shape-cast article comprises at least some of the silicon eutectic alloy.

[004] As used herein, a "silicon eutectic alloy" is an alloy having an aggregation of a first silicon phase and a second disilicide phase dispersed within the first phase. A silicon eutectic alloy does not have to be "perfectly eutectic", i.e., a silicon eutectic alloy does not need to have a composition that is located perfectly on the eutectic point of its corresponding phase diagram. For example, a Si-CrSi_{2} eutectic alloy has one eutectic point at about 24 wt. % Cr and 76 wt. % Si. However, compositions outside of this point may produce acceptable silicon eutectic alloys having a defined aggregation of a first phase and a second phase dispersed within the first phase. Three or more distinct phases may also be present. Some methods for producing silicon eutectic alloy products are disclosed in, for instance, WO201 1/022058 to Schuh et al. and U.S. Patent No. 4,724,233 to Ditchek et al, each of which is incorporated herein by reference in its entirety.

[005] As stated above, the silicon eutectic alloy includes a second phase comprising one or more disilicides, this second phase being sometimes referred to herein as reinforcement.
structures. Such reinforcement structures may have a high aspect ratio (e.g., in the form of rods and/or lamella and/or combinations thereof). In one embodiment, a long axis of at least some of the reinforcement structures is oriented substantially perpendicular to at least one intended viewing surfaces of the body. In one embodiment, the intended viewing surface may comprise at least one curved surface, and at least some of the reinforcement structures may be oriented substantially perpendicular to a respective nearest position on the curved wear surface. In other embodiments, a long axis of at least some of the reinforcement structures is parallel (or close to parallel) to an intended viewing surface of the body.

[006] The metallic element M may be any suitable element that can form a eutectic aggregation of silicon and disilicides. In one embodiment, the metallic element M is selected from the group consisting of chromium, titanium, cobalt, vanadium, niobium, platinum, palladium, and combinations thereof. In one embodiment, the metallic element M is cobalt (e.g., when the intended viewing surface is configured to comprise a bluish hue), and the disilicide is CoSi₂. In one embodiment, the metallic element M is titanium, and the disilicide is TiSi₂. In one embodiment, the metallic element M is chromium, and the disilicide is CrSi₂. In one embodiment, the metallic element M is vanadium, and the disilicide is VSi₂. In one embodiment, the metallic element M is niobium, and the disilicide is NbSi₂. In one embodiment, the metallic element M is platinum, and the disilicide is PtSi₂. In one embodiment, the metallic element M is palladium, and the disilicide is PdSi₂.

[007] In one approach, the silicon eutectic alloy is a binary alloy having silicon and one metallic element M, such as any of the Si-CoSi₂, Si-TiSi₂, Si-CrSi₂, Si-VSi₂, Si-NbSi₂, Si-PtSi₂, and Si-PdSi₂ alloys described above. In another approach, the silicon eutectic alloy is a ternary alloy having the silicon phase, the disilicide phase, and a third alloying element. The third alloying element may be selected from the group consisting of aluminum, silver, gold, and combinations thereof. In one embodiment, the third alloying element is aluminum. In one embodiment, the third alloying element is silver. In one embodiment, the third alloying element is gold. In this approach, the metallic element M of the disilicide phase may be any of the metals described above, i.e., any of chromium, titanium, cobalt, vanadium, niobium, platinum, palladium, and combinations thereof. In one embodiment, the metallic element M of the disilicide phase is selected from the group consisting of chromium, titanium, and cobalt.
The third alloying element may be included in the silicon eutectic alloy in the range of from about 0.05 to about 10 wt. %. The amount of the third alloying element is calculated based on the total weight amount of silicon and metallic element in the silicon eutectic alloy. For example, using a silicon-titanium eutectic alloy having additional aluminum as a basis for illustration, if a silicon-titanium eutectic alloy included 78.3 grams of silicon and 21.7 grams of titanium (includes slightly excess silicon to account for Si-Al eutectic), then the silicon eutectic alloy would have 100 grams of silicon + titanium. For this silicon-titanium eutectic alloy to have, by way of example, 4.0 wt. % Al, an additional 4.0 grams of aluminum would be added to this 100 grams of Si+Ti (4.0 grams of aluminum divided by 100 grams of Si+Ti = 4 wt. % Al). Slightly excess silicon may be added to compensate for the addition of the third alloying element. For example, when aluminum is used as the third alloying element, about 0.13 times the weight amount of aluminum may be added to compensate for silicon-aluminum eutectic that may be formed due to the addition of the aluminum. A similar approach may be employed for silver and gold, where excess silicon of about 0.31 times the weight amount of silver may be added when silver is employed, and where excess silicon of about 0.32 times the weight of gold may be added when gold is employed.

In one embodiment, a ternary silicon eutectic alloy (or a body made therefrom) includes not greater than 8 wt. % of the third alloying element. In another embodiment, a ternary silicon eutectic alloy (or a body made therefrom) includes not greater than 6 wt. % of the third alloying element. In yet another embodiment, a ternary silicon eutectic alloy (or a body made therefrom) includes not greater than 5.0 wt. % of the third alloying element. In another embodiment, a ternary silicon eutectic alloy (or a body made therefrom) includes not greater than 4.0 wt. % of the third alloying element. In yet another embodiment, a ternary silicon eutectic alloy (or a body made therefrom) includes not greater than 3.0 wt. % of the third alloying element. In another embodiment, a ternary silicon eutectic alloy (or a body made therefrom) includes not greater than 2.5 wt. % of the third alloying element. In one embodiment, a ternary silicon eutectic alloy (or a body made therefrom) includes at least 0.10 wt. % of the third alloying element. In another embodiment, a ternary silicon eutectic alloy (or a body made therefrom) includes at least 0.25 wt. % of the third alloying element. In yet another embodiment, a ternary silicon eutectic alloy (or a body made therefrom) includes at
least 0.35 wt. % of the third alloying element. In another embodiment, a ternary silicon eutectic alloy (or a body made therefrom) includes at least 0.50 wt. % of the third alloying element.

[0010] In one embodiment, the castability of silicon eutectic alloys may be improved due to the addition of the third alloying element. In this regard, a method may include flowing a molten mixture into a shape casting mold, wherein the molten mixture comprises (and in some instances consists essentially of) silicon, the metallic element M, and from 0.05 to 10 wt. % of the third alloying element. The method may include solidifying the molten mixture into a body corresponding to the shape of the shape casting mold, wherein the body comprises a eutectic aggregation of silicon, the disilicide phases and a phase of the third alloying element. The method may include extracting the body from the shape casting mold, wherein the body is crack-free. As used herein, "crack-free" means that the body is sufficiently free of cracks that it can be used as a decorative shape-cast article, or as a component of a decorative shape-cast article. For example, when the shape casting mold is in the form of a jewelry component, the jewelry component is crack-free when it can be used as the jewelry component for which it was intended. In one embodiment, the shape cast article is crack-free to the unaided, naked eye.

[0011] In one approach, a decorative shape-cast article includes at least one deposited substance located on at least a portion of at least one intended viewing surface of the decorative shape-cast article. Such deposited substance(s) may enhance the aesthetics and/or properties of the decorative shape-cast article. In one embodiment, the deposited substance comprises a decorative metal, and the decorative metal is located on only a portion of the intended viewing surface. Thus, both the silicon eutectic alloy and the decorative metal may be perceived on the intended viewing surface. In one embodiment, the decorative metal is a metal or metal alloy selected from the group consisting of aluminum, copper, silver, gold, titanium, platinum, palladium, rhodium, and combinations thereof. Other deposited substances are described below.

[0012] In one approach, a decorative shape-cast article includes multiple silicon eutectic alloys. For instance, a first silicon eutectic alloy may be shape cast into a first article. A second silicon eutectic alloy may be separately shape cast into a second article. The first silicon eutectic alloy article may be joined to the second silicon eutectic alloy article (e.g., by adhesive bonding the first and second articles, localized melting), and a decorative shape-cast
article may include these joined first and second silicon eutectic alloy articles. In one embodiment, the first silicon eutectic alloy is adjacent the second silicon eutectic alloy. In this regard, the first silicon eutectic alloy may include a first eutectic aggregation of silicon and a first disilicide phase \( \text{MISi}_2 \), where \( \text{M} \) is first metallic element, such as any of the metallic elements disclosed above. The second silicon eutectic alloy may include a second eutectic aggregation of silicon and a second disilicide phase \( \text{M}_2\text{Si}_2 \), where \( \text{M}_2 \) is second metallic element, different than the first metallic element \( \text{M}_1 \), and \( \text{M}_2 \) may be any of the metallic elements disclosed above. Such a decorative shape-cast article may include a body having at least one intended viewing surface, and an intended viewing surface may comprise both the first and the second silicon eutectic alloys. In one embodiment, a first portion of the intended viewing surface comprises the first silicon eutectic alloy and a second portion of the intended viewing surface comprises the second silicon eutectic alloy. Thus, a decorative shape-cast article may have an intended viewing surface having a first reflectivity value and a second portion having a second reflectivity value for a given wavelength of light. In one embodiment, a reflectivity value of the first portion is at least 1 percentage unit(s) different than a reflectivity value of a second portion, wherein the reflectivity value of the first portion and the reflectivity value of a second portion are determined at the same wavelength of light. In one embodiment, the wavelength of light is in the range of from 390 to 700 nanometers. For instance, at 550 nanometers, a surface of a mirror-polished \( \text{Si-TiSi}_2 \) alloy may realize a percent reflection value of about 47% (e.g., see, FIGS. 4a-4b). A different silicon eutectic alloy realizing a percent reflection value of 48% or higher, or 46% or lower, at a wavelength of 550 nm, thus realizes an at least 1 percentage unit different than the mirror-polished surface of the above \( \text{Si-TiSi}_2 \) alloy. As a specific example, a surface of a mirror-polished \( \text{Si-CoSi}_2 \) alloy may realize a percent reflection value of about 42% at a wavelength of 550 nm (e.g., see, FIGS. 4a-4b), which is about 5 percentage units lower than that of the mirror-polished surface of the \( \text{Si-TiSi}_2 \) article at the same wavelength of 550 nm. In one embodiment, the reflectivity value of the first portion is at least 2% different than the reflectivity value of the second portion. In another embodiment, the reflectivity value of the first portion is at least 3% different than the reflectivity value of the second portion. In yet another embodiment, the reflectivity value of the first portion is at least 4% different than the reflectivity value of the second portion. In another embodiment, the reflectivity value of the first portion is at least 5% different than the reflectivity value of the second portion. In yet another embodiment, the reflectivity value of the first portion is at
least 6% different than the reflectivity value of the second portion. In yet another embodiment, the reflectivity value of the first portion is at least 7% different than the reflectivity value of the second portion. In one embodiment, the reflectivity value of the first portion is not greater than 35% different than the reflectivity value of the second portion (e.g., when using different alloys and different finishing techniques for the different alloys). Thus, predetermined reflectivity differentials may be included in a decorative shape-cast article. For purposes of this patent application, reflectivity of an intended viewing surface is measured in accordance with ASTM E1331-09 and the diffuse-reflection mode, of an Agilent Cary 5000 (or similar spectrometer) from 250nm to 1700nm.

Methods of making decorative shape-cast articles are also disclosed. In one embodiment, and with reference now to FIG.1, a method may include selecting (100) a decorative shape-cast article for casting, such as any of the decorative shape-cast articles described below. The method may further include shape-casting (200) the decorative shape-cast article. In one embodiment, the shape-casting step (200) includes melting together silicon and one or more metallic elements in a eutectic alloy melt comprising silicon and the one or more metallic elements. Melt directionally removing heat from the eutectic alloy melt to directionally solidify the eutectic alloy melt, and forming a decorative shape-cast article (or a portion of a decorative shape-cast article) having a body with at least one intended viewing surface, where the intended viewing surface comprises at least some of the silicon eutectic alloy. The method may further include finishing (300) the decorative shape-cast article, such as by machining, polishing, grinding, honing, cutting, drilling and/or lapping, among other steps.

In one embodiment, the finishing (300) includes preparing a first portion of at least one intended viewing surface of the body to have a first predetermined reflectivity or reflectivity range at a given wavelength of light, and preparing a second portion of at least one intended viewing surface of the body to have to have a second reflectivity or reflectivity range at a given wavelength of light, where the first predetermined reflectivity is different than the second predetermined reflectivity. For instance, the first portion may be polished to a first finish (e.g., a 0.05 micron finish ~ the finishing media has a 0.05 micron size particle), and a second portion may be polished differently. Thus, predetermined reflectivity differentials may be included in a decorative shape-cast article. In one embodiment, the first portion has a percent reflection value in the range of 25 - 60%, and the second portion has a
reflectivity value that is at least 1 percentage unit(s) different than the first portion, wherein the percent reflection values of the first portion and the second portion are determined at the same wavelength of light. In one embodiment, the wavelength of light is in the range of from 390 to 700 nanometers. For instance, at 550 nanometers, a surface of a mirror-polished Si-CrSi$_2$ alloy may realize a percent reflection value of about 47% (e.g., see, FIGS. 3a-3b). Thus, another intended viewing surface that realizes a percent reflection value that is 48% or higher, or 46% or lower, is at least 1 percentage unit different than the mirror-polished surface of this Si-TiSi$_2$ article. As a specific example, a surface of a 600 grit polished Si-CrSi$_2$ alloy may realize a percent reflection value of about 29% at a wavelength of 550 um (e.g., see, FIGS. 3a-3b), which is 16 percentage units lower than the mirror-polished sample at the same wavelength. In one embodiment, the second portion has a reflectivity value that is at least 5 percentage units different than the reflectivity value of the first portion. In another embodiment, the second portion has a reflectivity value that is at least 10 percentage units different than the reflectivity value of the first portion. In another embodiment, the second portion has a reflectivity value that is at least 15 percentage units different than the reflectivity value of the first portion. In another embodiment, the second portion has a reflectivity value that is at least 20 percentage units different than the reflectivity value of the first portion. In one embodiment, the reflectivity of the first portion is not greater than 35 percentage units different than the reflectivity of the second portion.

**Definitions**

[0015] Unless otherwise indicated, the following definitions apply to this patent application.

[0016] As used herein, "shape-cast article" and the like means an article that achieves its final or near final product form after the casting process. A shape cast article is in final form if it requires no machining after casting. A shape cast article is in near final form if it requires some machining after casting. Shape cast articles may be produced via any suitable casting process, such as investment casting, rotary casting, permanent mold casting (e.g., graphite mold casting), sand casting, and die casting, among others known foundry processes. A shape casting mold may be used to produce a shape-cast article. A shape casting mold is any mold capable of producing a shape-cast article from a silicon eutectic alloy. Such molds include die casting molds, sand casting molds, investment casting molds, permanent graphite casting molds, rotary casting molds, and the like.
As used herein, "decorative shape-cast article" and the like means a shape-cast article whose intended final use is predominately for decorative purposes. Examples of decorative shape-cast articles include jewelry, decorative tiles (e.g., bathroom tiles, kitchen tiles), facades or cases (e.g., for consumer electronics, such as mobile phones), plates (name plates, covering plates, backing plates, dog tags), buttons, knobs and handles, faucets, sconces, chandeliers, and the like, which products may be used, for example, in jewelry applications, consumer electronic applications, automotive applications, and household applications, among others. For instance, after casting, a shape-cast article may be finished (e.g. polished) to produce a decorative shape cast article. This finishing may result in the shape-cast article having a predetermined reflectivity and/or texture, among other features, located on at least a portion of an intended viewing surface of the shape-cast article. Often these decorative shape-cast articles achieve a predetermined reflectivity and/or texture, among other features, that meets consumer acceptance standards. For purposes of this patent application, "decorative shape-cast articles" do not include predominately functional items such as, for instance, valves, gears, screws, turbines, tools, cutlery, cookware, solar panels, medical equipment, and electronic parts (e.g., semiconductor chips, field emission cathodes), among others.

As used herein, "intended viewing surface" and the like means surfaces that are intended to be viewed by a consumer during normal use of the product. For instance, as illustrated in FIGS. 2a-2b, a mobile electronic device cover 200 has a body 202 having intended viewing surfaces 204 and internal surfaces 206. Intended viewing surfaces, such as surfaces 204 illustrated in FIGS. 2a-2b, are surfaces that are intended to be viewed by a consumer during normal use of the product. Internal surfaces 206, such as surfaces 206 illustrated in FIGS. 2a-2b, are generally not intended to be viewed during normal use of the product. For example, the internal surfaces 206 of the mobile electronic device cover 200 are not normally viewed during normal use of the product (e.g., when using to send text messages and/or when using to converse telephonically), but may be occasionally viewed during non-normal usage, such as when changing the battery. Similar principles apply to other decorative shape cast articles.

As used herein, "wherein the at least one intended viewing surface comprises at least some of the silicon eutectic alloy" and the like means that at least some of the silicon eutectic alloy is purposefully visible to the human eye via the intended viewing surface.
[0020] As used herein, "deposited substance" and the like means a substance intentionally placed on at least a portion of a surface of the intended viewing surface of a decorative shape-cast article. For instance, inks, polymers (e.g., paints), metals, oxides (e.g., a variable thickness oxide coating for differing coloring purposes), or other substances may be intentionally placed on one or more portions of a decorative shape-cast article to provide, for instance, a logo or logos, differing contrast, color and/or reflectivity, or for adhesion purposes, among others. In one embodiment, the deposited substance comprises a decorative metal. In one embodiment, the deposited substance comprises a polymer (e.g., a colored or clear coat polymer). In one embodiment, the deposited substance is in the form of a film. In one embodiment, the deposited substance is in the form of a logo or other predetermined pattern (e.g., an alpha-numeric pattern). If the deposited substance is opaque, the deposited substance will generally only be placed on a portion of the intended viewing surface so as to facilitate viewing of both the deposited substance and the silicon eutectic alloy of the intended viewing surface. A native oxide layer that forms as a natural result of the formation of a decorative shape-cast article is not considered a "deposited substance" because a native oxide layer is not intentionally placed on at least a portion of a surface of the intended viewing surface of a decorative shape-cast article.  

[0021] As used herein, "decorative metal" and the like means a metal (or an alloy of that metal) that is intended to decorate a portion of an intended viewing surface of a decorative shape-cast article, such as via a predetermined pattern of decorative metal. Non-limiting examples of decorative metals include metallic and alloyed versions of aluminum, copper, silver, gold, titanium, palladium, rhodium, and combinations thereof. In one embodiment, the decorative metal comprises metallic silver and/or a silver alloy. In one embodiment, the decorative metal comprises metallic gold and/or a gold alloy. In one embodiment, the decorative metal comprises metallic copper and/or a copper alloy. In one embodiment, the decorative metal comprises metallic aluminum and/or an aluminum alloy. In one embodiment, the decorative metal comprises metallic titanium and/or a titanium alloy. In one embodiment, the decorative metal comprises metallic palladium and/or a palladium alloy. In one embodiment, the decorative metal comprises metallic rhodium and/or a rhodium alloy.  

**BRIEF DESCRIPTION OF THE DRAWINGS**  
[0022] FIG. 1 is a flow chart illustrating one embodiment of a method for making a decorative shape-cast article.
FIGS. 2a-2b are schematic views of a cover of a consumer electronic device illustrating both intended viewing surfaces (204) and non-intended viewing surfaces (e.g., internal surfaces 206).

FIG. 3a-3b are graphs illustrating reflectivity measurements as a function of wavelength for various materials of Example 1.

FIG. 4a-4b are graphs illustrating reflectivity data and photopic response as a function of wavelength for various materials of Example 1.

FIG. 5a-5b are graphs illustrating reflectivity measurements as a function of wavelength for various materials of Example 1.

FIG. 6 is a graph illustrating reflectivity differential as a function of wavelength for various materials, where the reflectivity differential is the difference between (a) a reflectivity measurement of a surface having a "mirror finish of 0.05 micron" and (b) a reflectivity of an unpolished surface having a 600 grit finish following an initial surface grinding, for a given wavelength of light.

**DETAILED DESCRIPTION**

**Example 1**

Charges of elemental silicon (Dow Corning, PV1101, 99.999% purity level silicon), and metals selected from the appropriate eutectic compositions of Chromium (Atlantic Metals, 99.99%), Cobalt (Atlantic Metals, 99.95%), Titanium (Atlantic Metals, 99.995%) and aluminum (Atlantic metals, 99.99%) of the appropriate ratios (listed in Table 1, below) were melted and then directionally solidified in a graphite crucible (6.5" x 3.5" x 2.5") under vacuum.

**Table 1 - Silicon Eutectic Alloys - Charged Weights**

<table>
<thead>
<tr>
<th>Base Eutectic</th>
<th>Si (g)</th>
<th>Cr (g)</th>
<th>Ti (g)</th>
<th>Co (g)</th>
<th>Al (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Si-CrSi₂</td>
<td>1292</td>
<td>408</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Si-CrSi₃</td>
<td>1296.4</td>
<td>408</td>
<td>--</td>
<td>--</td>
<td>34</td>
</tr>
<tr>
<td>Si-TiSi₂</td>
<td>1332</td>
<td>--</td>
<td>369</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Si-TiSi₃</td>
<td>1332.2</td>
<td>--</td>
<td>369.7</td>
<td>--</td>
<td>8.5</td>
</tr>
<tr>
<td>Si-CoSi₂</td>
<td>933</td>
<td>--</td>
<td>--</td>
<td>563.2</td>
<td>--</td>
</tr>
</tbody>
</table>
Sample coupons from each composition were sectioned using a diamond wheel saw and polished using diamond bonded metal pads and diamond abrasive slurry to a mirror finish of 0.05 micron. Other sample coupons were finished with a 600 grit finish following an initial surface grinding.

UV-Vis reflectivity analysis of the samples was performed using an Agilent Cary 5000 Spectrophotometer in diffuse reflection mode from 250 to 1700 nm. Comparison of alloy samples was performed using a gold plated silicon wafer, a polished Aluminum mirror and a polished silicon wafer. Various reflectivity results are shown in FIGS. 3a-3b, 4a-4b, 5a-5b and 6. Visual analysis of the materials indicates that the materials would be fit for decorative applications.

While various embodiments of the present disclosure have been described in detail, it is apparent that modifications and adaptations of those embodiments will occur to those skilled in the art. However, it is to be expressly understood that such modifications and adaptations are within the spirit and scope of the present disclosure.
CLAIMS

What is claimed is:

1. A decorative shape-cast article comprising a body having at least one intended viewing surface;
   wherein the body of the decorative shape-cast article comprises a silicon eutectic alloy;
   wherein the silicon eutectic alloy comprises a eutectic aggregation of silicon and disilicides of a formula $MS_{12}$, wherein $M$ is a metallic element;
   wherein the at least one intended viewing surface of the decorative shape-cast article comprises at least some of the silicon eutectic alloy.

2. The decorative shape-cast article of claim 1, wherein the metallic element $M$ of the disilicide phase is cobalt.

3. The decorative shape-cast article of claim 1, wherein the silicon eutectic alloy is a ternary alloy having the silicon, the disilicide phase, and a third alloying element, wherein the metallic element $M$ of the disilicide phase is selected from the group consisting of chromium, titanium, cobalt, vanadium, niobium, platinum, and palladium, and wherein the third alloying element is selected from the group consisting of aluminum, silver, gold, and combinations thereof.

4. The decorative shape-cast article of claim 3, wherein the metallic element $M$ of the disilicide phase is selected from the group consisting of chromium, titanium, and cobalt.

5. The decorative shape-cast article of claim 4, wherein the metallic element $M$ of the disilicide phase is chromium and wherein the third alloying element is either silver or gold.

6. The decorative shape-cast article of claim 4, wherein the metallic element $M$ of the disilicide phase is titanium and wherein the third alloying element is either silver or gold.
7. The decorative shape-cast article of claim 4, wherein the metallic element $M$ of the disilicide phase is cobalt and wherein the third alloying element is either silver or gold.

8. The decorative shape-cast article of any of claims 1-7, comprising a deposited substance located on at least a portion of the intended viewing surface of the decorative shape-cast article.

9. The decorative shape-cast article of claim 8, wherein the deposited substance comprises a decorative metal, and wherein the decorative metal is located on only a portion of the intended viewing surface.

10. The decorative shape-cast article of claim 9, wherein the decorative metal is selected from the group consisting of aluminum, copper, silver, gold, titanium, platinum, palladium, rhodium, and combinations thereof.

11. The decorative shape-cast article of claim 1, wherein the silicon eutectic alloy is a first silicon eutectic alloy, the eutectic aggregation is a first eutectic aggregation, the metallic element is a first metallic element $M_1$, and wherein the disilicide phase is a first disilicide phase comprising the first metallic element $M_1$ and having formula $M_1Si_2$;

   wherein the body of the decorative shape-cast article comprises a second silicon eutectic alloy, wherein the second silicon eutectic alloy comprises a second eutectic aggregation of silicon and second disilicides of a formula $M_2S_2$, wherein $M_2$ is a second metallic element, and wherein the second metallic element $M_2$ is different than the first metallic element $M_1$;

   wherein at least one intended viewing surface of the decorative shape-cast article comprises at least some of at least one of the first silicon eutectic alloy and the second silicon eutectic alloy.

12. The decorative shape-cast article of claim 11, wherein the first silicon eutectic alloy is adjacent the second silicon eutectic alloy.
13. The decorative shape-cast article of any of claims 11-12, wherein a first portion of the intended viewing surface comprises the first silicon eutectic alloy and a second portion of the intended viewing surface comprises the second silicon eutectic alloy.

14. The decorative shape-cast article of claim 13, wherein a reflectivity of the first portion is at least 1 percentage unit different than a reflectivity of a second portion, wherein the reflectivity of the first portion and the reflectivity of a second portion are determined at the same wavelength of light, and wherein the wavelength of light is in the range of from 390 to 700 nanometers.

15. The decorative shape-cast article of any of claims 1-10, wherein the intended viewing surface comprises a first portion and a second portion, wherein both the first portion and the second portion comprise the silicon eutectic alloy, and wherein the first portion has a reflectivity in the range of 25-60% R, and wherein the second portion has a reflectivity that is at least 1 percentage unit different than the reflectivity of the first portion, wherein the reflectivity of the first portion and the reflectivity of a second portion are determined at the same wavelength of light, and wherein the wavelength of light is in the range of from 390 to 700 nanometers.
Select decorative article

100

Shape-cast decorative article from silicon-eutectic alloys

200

Finish decorative shape-cast article

300

FIG. 1
FIG. 3a - Measured Reflectivity vs. Wavelength of Light

- Si-CoSi2
- Si-CoSi2 600 grit
- Si-CoSi2 + Al (2%)
- Si-CoSi2 (2%) 600 grit
- Si-CSi2 + Al (2%) 600 grit

Reflectivity (%)
Wavelength
FIG. 5b - Measured Reflectivity v. Wavelength of Light

- Aluminum Mirror
- Gold Plated Si Wafer
- Si-TiSi2 + Al (0.5%)
- Si-TiSi2
- Si-CrSi2
- Si-CrSi2
- Si-CrSi2 + Al (2%)
FIG. 6 - Reflectivity difference between 0.05 micron finish and 600 grit finish
### A. CLASSIFICATION OF SUBJECT MATTER

INV. C22C28/00

According to International Patent Classification (IPC) or to both national classification and IPC

### B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C22C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>examples Group 4,5,6,9: table 1 page 9, line 22 - line 30 page 13, paragraph 2 - paragraph 4 page 14, paragraph 2 page 15, paragraph 2 - page 16, paragraph 1 page 27, paragraph 2 page 38, paragraph 1 - paragraph 2 figures 3,4,5,9,20 claims 28,43,44,66,67</td>
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* Special categories of cited documents:

- **A** document defining the general state of the art which is not considered to be of particular relevance
- **E** earlier application or patent but published on or after the international filing date
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- **O** document referring to an oral disclosure, use, exhibition or other means
- **P** document published prior to the international filing date but later than the priority date claimed

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Name and mailing address of the ISA:

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Fax: (+31-70) 140-3016

Authorized officer:

Rolle, Susett
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