Sept. 22, 1964 K. A. GSCHNEIDNER, JR 3,149,966

OXIDATION RESISTANT CERIUM ALLOYS

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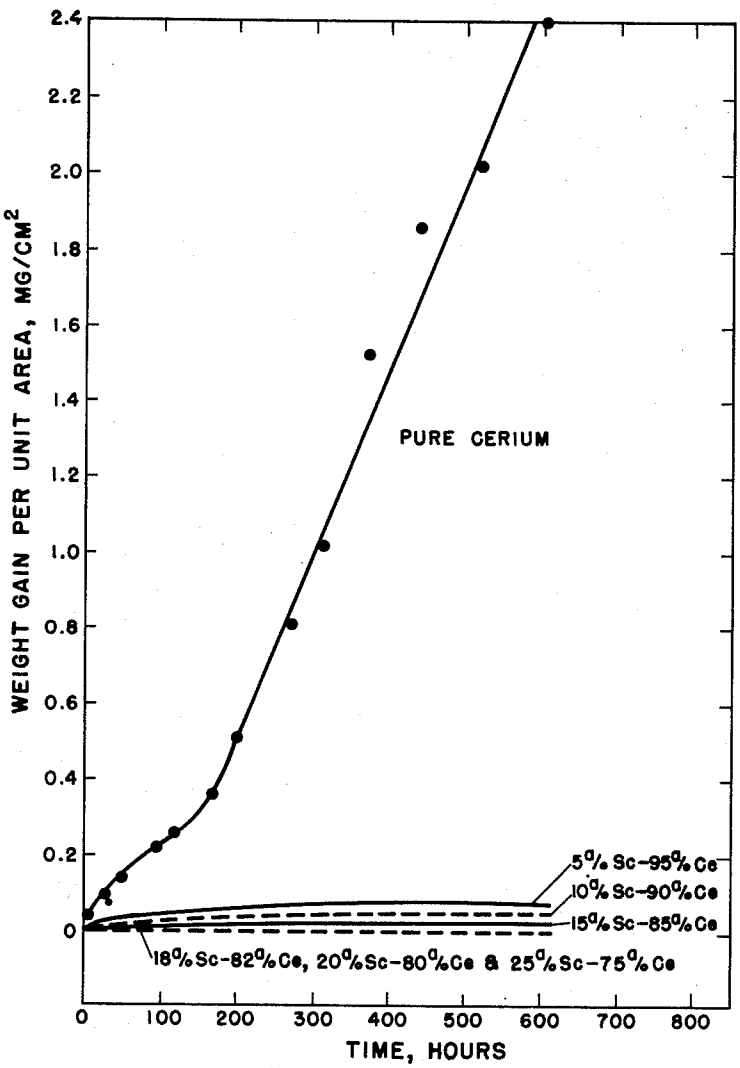


Fig. 1

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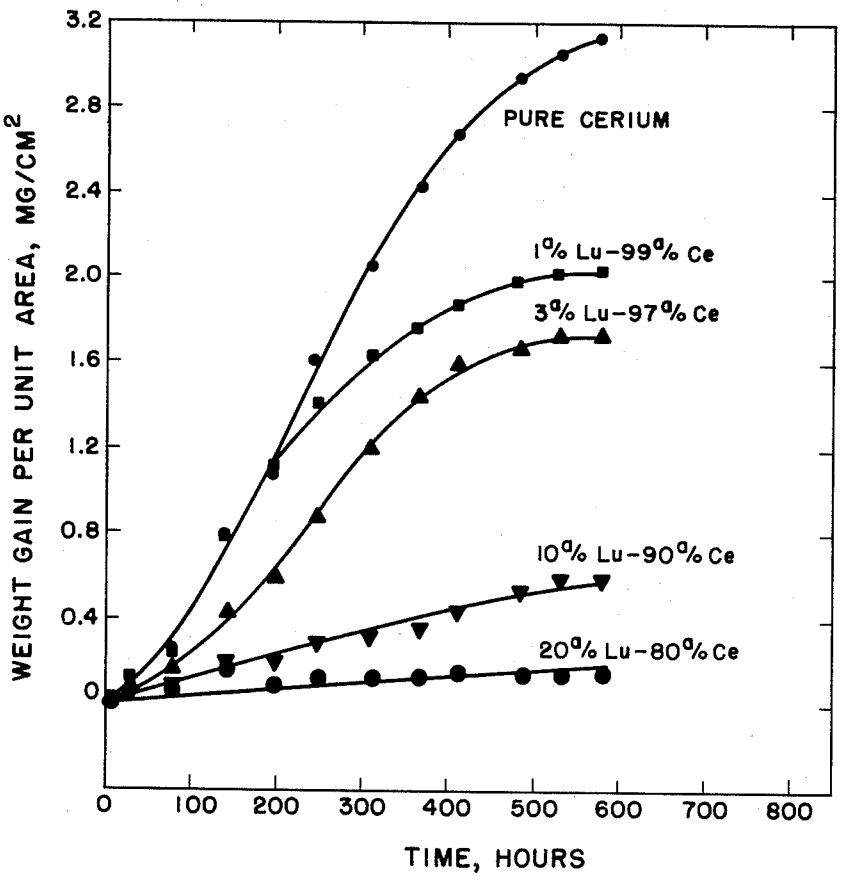


Fig. 2

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OXIDATION RESISTANT CERIUM ALLOYS

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6 Claims. (Cl. 75—152)

The present invention relates to alloys of cerium and more specifically to cerium-scandium and cerium-lutetium alloys which are oxidation resistant and are more ductile and malleable than cerium metal.

Cerium metal has many uses as an additive to iron, steel, magnesium and other alloys. However, special precautions must be used to prevent this metal from oxidizing before it is alloyed. At present, cerium metal is stored under a vacuum or in an oil bath to prevent or reduce its oxidation. Both of these storing methods are undesirable in that a vacuum system is costly and time consuming in operation, while an oil bath has obvious disadvantages and does not prevent but only reduces the oxidation rate of cerium. This oxide film must be cleaned off in a vacuum chamber which for the reasons mentioned is also unsatisfactory. Thus, an effective oxidation inhibitor for cerium metal that would allow the use of ordinary methods of storing and handling is sorely needed.

It has been found that cerium metal, when alloyed with relatively small amounts of scandium and lutetium is totally, or almost totally, oxidation resistant at room temperature. Furthermore, the addition of scandium or lutetium to cerium results in the formation of a single phase alloy that has the property of being easy to fabricate into any desired shape using standard metallurgical techniques.

It is therefore an object of this invention to provide an alloy of cerium that will not oxidize at room temperature and is easy to fabricate.

It is a further object of this invention to provide an alloy of cerium that is resistant to oxidation at room temperature.

Further objects of this invention will be apparent from the following description and FIGURES 1 and 2 which are hereby made a part of this specification.

FIGURE 1 is a graph showing the oxidation rate of cerium and cerium-scandium alloys over a specified time interval at room temperature, and

FIGURE 2 is a graph showing the oxidation rate of cerium and cerium-lutetium alloys over a specified time interval at room temperature.

The preferred embodiment of the present invention comprises an alloy of cerium and scandium consisting of at least 18 atomic percent scandium and the balance cerium.

Preparation

6.6 grams of scandium and 93.4 grams of cerium are melted together under a vacuum or inert gas atmosphere and cast into an ingot. The ingot is subsequently heat treated for a minimum of 200 hours at a temperature of 450° C. After this homogenization treatment, the ingot is cooled to room temperature and is now ready to be stored or fabricated.

In a similar manner, lutetium can be alloyed with cerium except that at least 20 atomic percent lutetium must be added to the cerium to obtain the same oxidation rate which the addition of 5 atomic percent scandium would accomplish (see FIGURES 1 and 2).

Since lutetium has an atomic weight greater than cerium, the weight composition of 20 atomic percent lutetium–80 atomic percent cerium alloy would be approximate in the weight-ratio of 25 to 75 respectively for a 100-gram ingot.

As can be seen from the graph in FIGURE 1, as little as 5 atomic percent scandium–95 atomic percent cerium has a decided effect on reducing the oxidation rate of cerium. Where the use of cerium requires that its oxidation be totally inhibited, an alloy composition of at least 18 atomic percent scandium, balance cerium, is necessary. Additional amounts in excess of 18 atomic percent scandium serves no useful purpose. In applications of cerium metal where an oxidation rate of 0.0001 gram per centimeter squared per 600 hours can be tolerated, either a 5 atomic percent scandium or a 20 atomic percent lutetium-cerium alloy can be used (see FIGURES 1 and 2).

Physical Properties of the Alloys

The addition of as little as 5 atomic percent scandium to cerium causes the formation of an alloy that is a solid solution having a face-centered cubic crystalline structure. Such a single phase alloy has the inherent property of being easy to work or fabricate. Likewise, the addition of more than 10 atomic percent lutetium to cerium stabilizes the hexagonal crystalline form of cerium which is also easy to fabricate, but not quite as easy as the face-centered cubic form.

While the invention has been disclosed with respect to a single preferred embodiment, it will be apparent to those skilled in the art that variations and modifications may be made within the spirit and scope of this invention and thus it is not intended to limit the invention except as defined in the following claims.

What is claimed is:

1. A ductile and malleable cerium base alloy that is oxidation resistant at room temperature, said alloy consisting of an oxidizing inhibitor selected from the class consisting of scandium and lutetium, said alloy containing at least 10 atomic percent of said inhibitor and the balance cerium.

2. A ductile non-oxidizing and malleable cerium base alloy at room temperature, said alloy consisting of at least 18 atomic percent scandium and the balance cerium.

3. A ductile and malleable cerium base alloy that is oxidation resistant at room temperature, said alloy consisting of at least 20 atomic percent lutetium and the balance cerium.

4. A process for making a ductile, malleable cerium based alloy that is oxidation resistant at room temperature consisting of the following steps:

(*a*) melting at least 10 atomic percent of an oxidizing inhibitor selected from the class consisting of scandium and lutetium with cerium under an inert atmosphere,

(*b*) casting the melt into an ingot,

(*c*) heat treating said ingot for a minimum of 200 hours at 450° C., and

(*d*) cooling said ingot to room temperature.

5. The process of claim 4 in which said oxidation inhibitor is scandium, said scandium being added to the cerium so that the resulting cerium-scandium alloy contains at least 18 atomic percent of scandium.

6. The process of claim 4 in which said oxidation inhibitor is lutetium, said lutetium being added to the cerium so that the resulting cerium-lutetium alloy contains at least 20 atomic percent lutetium.

References Cited in the file of this patent

Gschneidner, Jr., et al.: "Raw Earth Research" (edited by Kleber), Macmillan Co., New York, 1961, pp. 282–286 (date relied on is 1960 in which year the Arrowhead Research Conference was held on which the publication is based).