PRODUCING VOID-FREE METAL ALLOY POWDERS BY MELTING AS WELL AS ATOMIZATION UNDER NITROGEN AMBIENT

TECHNICAL FIELD

The present invention relates to a process for producing nitrogenated alloys and articles from such alloys. In particular, the present invention relates to a gas atomization method for producing nitrogenated alloys which are subsequently processed by powder metallurgy methods.

BACKGROUND ART

Nitrogen-containing austenitic stainless steels have been developed as engineering materials in order to take advantage of their enhanced strength and resistance to corrosion as compared to non-nitrogenated alloys. In addition to having enhanced strength and resistance to corrosion, nitrogen-containing austenitic stainless steels retain their low temperature toughness and high weldability which is typical of austenitic stainless steels. Nitrogen-containing stainless steel are further less prone to sensitization and more suitable for high temperature exposure. These qualities and others make nitrogenated alloys, particularly stainless steels candidate materials for applications wherein moderately high strength, good corrosion and oxidation resistance, and high toughness are required of non-magnetic alloys.

Limiting factors in the application of nitrogenated alloys, particularly nitrogenated stainless steel alloys is the difficulty of incorporating a controllable, homogeneous concentration of nitrogen into the metal. Current methods include melting and casting austenitic stainless steels alloys under high pressure nitrogen. In such cases, the cast ingot is processed in much the same manner as any casting method: drawing, rolling, or other forming operations are necessary to attain desirable shape.

Other methods of producing nitrogenated alloys include adding nitrogenous materials to the slag during electro-slag remelting.

Other general methods of processing metal alloys which are not concerned with nitrogenation include gas atomization or powder metallurgy in which alloy melts are atomized in various gaseous environments.

Hede U.S. Pat. No. 4,340,432 discloses a method of manufacturing stainless ferritic-austenitic steel which involves preparing a melt of steel with a nitrogen content higher than about 0.10 percent and an austenitic content of not less than 20 percent. The melt is subjected to gas atomization to form a powder which is compacted by an isostatic or semiisostatic compaction procedure to form a body which is heat treated and cooled. Hede discloses utilizing either nitrogen or argon during the gas atomization.

U.S. Pat. No. 3,891,730 to Wessel et al discloses a method for producing a metal powder which involves atomizing a hollow stream of molten metal, utilizing a pressurized fluid. Wessel et al do not disclose the selective use of nitrogen as an atomizing agent.

U.S. Pat. No. 4,919,854, to Walz, discloses a method and apparatus for producing superfine powder in spherical form with a diameter of about 5 to 30 microns in a Laval nozzle system. Walz discloses suitable inert gas propellants, specifically noting that nitrogen may be utilized with metals which do not form nitrides.

U.S. Pat. No. 4,448,746, to Kubo et al discloses a process for producing alloy steel powder, particularly low-oxygen, low-carbon alloy steel powder. The process involves atomizing a molten steel by means of an atomizing agent containing a non-oxidizing media. Kubo et al utilize an oil atomization process.

U.S. Pat. No. 3,658,311 to Di Giambattista et al discloses an apparatus for making a metal powder. However, Di Giambattista et al disclose the use of argon in their system.

U.S. Pat. No. 2,638,630 to Golwynne discloses a method for the production of a metal powder which specifically avoids nitrogen contamination.

Current gas atomization processes utilized to produce powders of various metal alloys generally utilize any arbitrary inert gas including argon and helium even though the use of certain inert gases such as argon and helium in a gas atomization process results in the formation of hollow gas-filled particles. Articles formed from metal powders which contain such hollow gas- filled particles disadvantageously have structural defects which contribute to shortened fatigue life and, ultimately, the failure of the component article or device.

The present invention is an improvement over the prior art which produces nitrogenated alloy powders while avoiding the formation of hollow gas-filled alloy particles.

DISCLOSURE OF THE INVENTION

It is accordingly, one object of the present invention to provide a method of gas atomization of a large variety of alloys which avoids the formation of hollow gas-filled alloy particles.

Another object of the present invention is to provide a method of producing a large variety of nitrogenated alloy powders.

A further object of the present invention is to provide a method of producing a large variety of nitrogenated alloy powders which have improved mechanical properties.

A further object of the present invention is to provide a method of producing articles from a large variety of nitrogenated alloys.

A still further object of the present invention is to provide a large variety of novel nitrogenated alloy powders and articles formed from such alloy particles.

Accordingly, the present invention provides for a method of producing a nitrogenated metal alloy powder which involves melting a metal alloy under a nitrogen containing atmosphere to increase the nitrogen content of the alloy and, thereafter subjecting the molten alloy to a gas atomization process in which nitrogen is utilized as the atomizing gas.

The present invention further provides for a method of fabricating a metal alloy article which comprises consolidating a nitrogenated metal alloy powder produced by: melting a metal alloy under a nitrogen containing atmosphere to increase the nitrogen content of the alloy; and thereafter subjecting the molten alloy to a gas atomization process in which nitrogen is utilized as the atomizing gas.

BRIEF DESCRIPTION OF DRAWINGS

Aspects of the present invention will be described with reference to the annexed drawings, which are given by way of non-limiting examples, in which:

FIG. 1 is a bar graph of the weight percent of nitrogen for each of the first 4 samples listed in Table I.