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The Director

of the United States Patent and Trademark Office has received an application for a patent for a new and useful invention. The title and description of the invention are enclosed. The requirements of law have been complied with, and it has been determined that a patent on the invention shall be granted under the law.

Therefore, this United States

Patent

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Katherine Kelly Vidal

DIRECTOR OF THE UNITED STATES PATENT AND TRADEMARK OFFICE



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(12) **United States Patent**
Hitit et al.

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(54) **NICKEL-BASED BULK METALLIC GLASS ALLOYS CONTAINING HIGH AMOUNT OF REFRACTORY METAL AND BORON**

(52) **U.S. Cl.**
CPC *C22C 45/04* (2013.01); *C22C 19/03* (2013.01); *C22F 1/10* (2013.01); *C22C 2200/02* (2013.01)

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(58) **Field of Classification Search**
None
See application file for complete search history.

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(56) **References Cited**

U.S. PATENT DOCUMENTS

4,210,443 A * 7/1980 Ray C22C 45/02 148/403
4,410,490 A 10/1983 Ray et al.
2014/0130945 A1 5/2014 Na et al.
2014/0238551 A1 8/2014 Na et al.
2016/0090644 A1 * 3/2016 Na C22C 45/04 148/555

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 494 days.

FOREIGN PATENT DOCUMENTS

CN 1354274 A 6/2002
CN 101532153 A 9/2009
CN 103189539 A 7/2013
KR 20010096915 A 11/2001
WO 2012053570 A1 4/2012

* cited by examiner

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(57) **ABSTRACT**

First nickel-based bulk metallic glass alloys having a high glass forming ability, wherein in the first nickel-based bulk metallic glass alloys both a phase having a high fracture toughness, a nickel solid solution and borides having a high hardness is formed by a heat treatment at temperatures above crystallization temperatures.

2 Claims, 4 Drawing Sheets

