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(54) Starting material for permanent magnets.

(57) Hard-magnetic materials having a high crystal anisotropy on a carbide basis of the general formula $(RE_{1-x}Nd_x)_2Fe_{14}C$, wherein
RE is a rare earth metal having an atomic number exceeding 61 and $0.50 \leq x \leq 0.80$ have a comparatively high Curie-temperature.

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Starting material for permanent magnets.

The invention relates to a hard-magnetic material which comprises neodymium and iron.

A known material of this type is the $Nd_2 Fe_{14} B$ having a tetragonal crystal structure. It is known that a substitution of B by C in this compound leads to a greater anisotropy (see, for example, Journal de Physique Colloque C6, supplément au no. 9, T. 46, September, 1985, pages C6-305/308: "Magnetic anisotropy of Carbon Doped $Nd_2Fe_{14}B$" by Bolzoni, Leccabue, Pareti and Sanchez). It is stated in this article on page 306 that it was not possible to obtain the tetragonal phase when borium was replaced entirely by carbon.

It is the object of the invention to provide a hard-magnetic material having a great crystal anisotropy which comprises only carbon instead of boron and also a comparatively high content of neodymium.

It has been found that this object can be achieved by means of a substance of the following composition:

$(RE_{1-x}Nd_x)\ Fe_{14}C$,

wherein RE is one or more rare earth metals having an atomic number exceeding 61 (for example Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Lu) and

$0.5 \leq x \leq 0.80$.

It has been found that the magnetic properties decrease substantially if $x < 0.5$ or if $x > 0.8$.

In all the combinations a carbide having a tetragonal crystal structure is found. The Curie-temperature is between 500 and 600 K. The hard-magnetic materials according to the invention can be obtained in the conventional manner by fusing starting materials suitable for that purpose succeeded by an annealing treatment in a protective gas or another vacuum. A number of materials which were obtained in this manner are collected in the following table which also states the Curie-temperature and the annealing temperature.

Table

Compound	Curie-temperature (K)	Annealing temperature (°C)
$TbNdFe_{14}C$	560	850
$Tb_{0.5}Nd_{1.5}Fe_{14}C$	550	800
$Dy_{0.5}Nd_{1.5}Fe_{14}C$	545	850
$LuNdFe_{14}C$	530	850

The magnetic properties are comparable to those of materials on the basis of $Nd_2Fe_{14}B$ or better. The absence of boron is an advantage since now poisonous volatile boron compounds cannot be formed in the preparation.

Magnets in the form of shaped bodies can be sintered from the resulting material after pulverisation in the manner conventional with $Nd_2Fe_{14}B$.

Claims

1. A hard-magnetic material which comprises neodymium and iron, characterized in that the material has the composition $(RE_{1-x}Nd_x)\ Fe_{14}C$, wherein RE is Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm and/or Lu and $0.5 \leq x \leq 0.8$.

2. A permanent magnet on the basis of a material as claimed in Claim 1.

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EUROPEAN SEARCH REPORT

Application Number

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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	MATERIALS LETTERS, vol. 4, nrs. 8,9, August 1986, pages 377-380, Elsevier Science Publishers B.V., Amsterdam, NL; N.C. LIU et al.: "High coercivity permanent magnet materials based on iron-rare-earth-carbon alloys" * Whole document * ---	1,2	H 01 F 1/04
A	JOURNAL OF APPLIED PHYSICS, vol. 61, no. 8, 15th April 1987, pages 3574-3576, American Institute of Physics, New York, US; N.C. LIU et al.: "High intrinsic coercivities in iron-rare earth-carbon-boron alloys through the carbide or boro-carbide Fe14R2X(X=BxC1-x)" * Page 3575, left-hand column, last paragraphe * -----	1,2	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

H 01 F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	15-11-1988	DECANNIERE L.J.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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