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Rare earth — Vocabulary —

Part 2: Metals and their alloys

Terres rares — Vocabulaire —

Partie 2: Métaux et alliages

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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This document was prepared by Technical Committee ISO/TC 298, *Rare earth*.

A list of all parts in the ISO 22444 series can be found on the ISO website.

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Introduction

Rare earth metals and their alloys are key raw materials for developing high-performance rare earth functional materials, such as hydrogen-storage materials, magnetic materials and superconducting materials, and are widely used in fields such as sustainable energy, robotics and electronic information.

Rare earth metals are also important additive elements for aluminium-base, magnesium-base, copper-base, titanium-base and other alloys.

This document specifies terms for use by producers, consumers and traders in the field of rare earth metals and their alloys. This document will serve as a reference that will help to reduce discrepancies or trade disputes caused by inconsistencies in terms used when dealing with rare earth metals and their alloys.

Rare earth — Vocabulary —

Part 2: Metals and their alloys

1 Scope

This document defines the terms for rare earth metals and their alloys, as well as for methods of preparation and purification.

This document can be used as a reference to unify technical terms in rare earth production, application, inspection, circulation, trading, scientific research and education.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
rare earth impurity
undesirable rare earth element present in a *rare earth metal* (4.1) or *rare earth alloy* (5.1) other than the specified or target rare earth element(s)

3.2
non-rare earth impurity
undesirable non-rare earth element present in a *rare earth metal* (4.1) or *rare earth alloy* (5.1)

3.3
interstitial impurity
undesirable, non-metallic element such as hydrogen, boron, carbon, nitrogen or oxygen occupying interstitial positions in the lattice of a *rare earth metal* (4.1) or *rare earth alloy* (5.1)

3.4
rare earth metal content
total rare earth metal content
mass fraction of rare earth elements in a *rare earth metal* (4.1) or *rare earth alloy* (5.1)

Note 1 to entry: It is generally provided as a percentage of the metal, i.e. % TREM.

3.5
average atomic mass of rare earths in mixed rare earth metals or alloys
$\bar{M}$
ratio of the total mass of rare earth elements to their total number of moles, as shown by the formula:

$$\bar{M} = \frac{m_{\text{total}}}{n_{\text{total}}} = \frac{\sum_{i=1}^{N} m_i}{\sum_{i=1}^{N} \frac{m_i}{M_i}} = \frac{m_1 + m_2 + \ldots + m_N}{\frac{m_1}{M_1} + \frac{m_2}{M_2} + \ldots + \frac{m_N}{M_N}}$$

where

m_{total} is total mass of rare earth elements, in g;

n_{total} is total number of moles of rare earth elements, in moles;

m_i is mass of rare earth element i, i = 1, 2, ..., N, in g;

M_i is atomic mass of rare earth element i, i = 1, 2, ..., N, in g/mol.

Note 1 to entry: $\bar{M}$ is given in g/mol.

EXAMPLE 1 The average atomic mass of a *mixed rare earth metal* (4.4) containing 20 % mass of praseodymium and 80 % of neodymium is calculated as follows:

m_{Pr} = 20 units, m_{Nd} = 80 units, M_{Pr} = 140,907 7 g/mol, M_{Nd} = 144,24 g/mol

$$\bar{M} = \frac{20+80}{\frac{20}{140{,}907\,7} + \frac{80}{144{,}24}} = 143{,}56$$

EXAMPLE 2 The average atomic mass of rare earths in *Tb-Dy-Fe* (5.21) magnetostrictive materials, of which the formula is $Tb_{0,3}Dy_{0,7}Fe_2$, is calculated as follows:

M_{Tb} = 158,9254 g/mol, M_{Dy} = 162,5 g/mol, M_{Fe} = 55,847 g/mol

$m_{\text{Tb}} = \text{M}_{\text{Tb}} \times 0{,}3 \,/\, (M_{\text{Tb}} \times 0{,}3 + M_{\text{Dy}} \times 0{,}7 + M_{\text{Fe}} \times 2) \times 100 = 17{,}46$ units

$m_{\text{Dy}} = \text{M}_{\text{Dy}} \times 0{,}7 \,/\, (M_{\text{Tb}} \times 0{,}3 + M_{\text{Dy}} \times 0{,}7 + M_{\text{Fe}} \times 2) \times 100 = 41{,}65$ units

$$\bar{M} = \frac{17{,}46+41{,}65}{\frac{17{,}46}{158{,}925\,4} + \frac{41{,}65}{162{,}5}} = 161{,}43$$

3.6
rare earth metal purity
absolute rare earth metal purity
mass fraction of a specified rare earth element in a metal

Note 1 to entry: It is expressed as a percentage.

3.7
relative rare earth metal purity
mass fraction of the specified rare earth element out of the *rare earth metal content* (3.4)

Note 1 to entry: It is expressed as a percentage, i.e. Nd/TREM.

4 Terms related to rare earth metals

4.1
rare earth metal
metallic substance containing one or more rare earth elements

4.2
individual rare earth metal
metallic substance containing only one rare earth element, including La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Sc and Y

Note 1 to entry: The basic information for each rare earth element is given in ISO 22444-1:2020, Table A.1. The basic properties of *rare earth metals* (4.1) are given in Table A.1.

4.3
high purity rare earth metal
individual rare earth metal (4.2) with a minimum *rare earth metal purity* (3.6) of 99,9 %

Note 1 to entry: The main impurities to be controlled typically include *rare earth impurities* (3.1), Si, K, Na, Ca, Mg, Al, Ti, Ni, Co, Mn, Cu, Fe, Pb, Zn, Sn, Cd, Ta, Nb, Cr, W, Mo, C, S, P, Cl, F, N and O.

4.4
mixed rare earth metal
metallic substance containing two or more rare earth elements

4.5
mischmetal
metallic substance mainly containing the rare earth elements Ce and La as major components, with small amounts of Nd, Pr, etc., of which the compositional ratio of each REE is typically similar to that found in the resource minerals

4.6
Pr-Nd metal
didymium
metallic substance containing the rare earth elements of Pr and Nd

Note 1 to entry: It is occasionally represented by the abbreviation Di.

Note 2 to entry: The content of Pr in Di is generally more than 18 %.

4.7
La-Ce metal
metallic substance containing the rare earth elements of La and Ce

5 Terms related to rare earth alloys

5.1
rare earth alloy
metallic substance containing one or more rare earth elements and one or more non-rare earth metal(s) or semi-metal element(s)

Note 1 to entry: The alloys may be compounds, solid solutions, intermetallics or mixtures of the components.

5.2
rare earth master alloy
rare earth alloy (5.1) of selected rare earth element(s) that can be added to a charge of molten metal to provide a desired composition or texture or to deoxidize the material

Note 1 to entry: The content of rare earth element(s) in rare earth master alloy is generally higher than that in the *rare earth modified alloy* (5.10).