

Handbook on Rare Earth Metals and Alloys (Properties, Extraction, Preparation and Applications)

Author:- NPCS Board of Consultants & Engineers

Format: paperback

Code: NI218

Pages: 688

Price: Rs.1875US\$ 150

Publisher: NIIR PROJECT CONSULTANCY SERVICES

Usually ships within **5** days

Rare earths are essential constituents of more than 100 mineral species and present in many more through substitution. They have a marked geochemical affinity for calcium, titanium, niobium, zirconium, fluoride, phosphate and carbonate ions. Industrially important minerals, which are utilized at present for rare earths production, are essentially three, namely monazite, bastnasite and xenotime. In modern time techniques for exploration of rare earths and yttrium minerals include geologic identification of environments of deposition and surface as well as airborne reconnaissance with magnetometric and radiometric equipment. There are numerous applications of rare earths such as in glass making industry, cracking catalysts, electronic and optoelectronic devices, medical technology, nuclear technology, agriculture, plastic industry etc. Lot of metals and alloys called rare earth are lying in the earth which required to be processed. Some of the important elements extracted from rare earths are uranium, lithium, beryllium, selenium, platinum metals, tantalum, silicon, molybdenum, manganese, chromium, cadmium, titanium, tungsten, zirconium etc. There are different methods involved in production of metals and non metals from rare earths for example; separation, primary crushing, secondary crushing, wet grinding, dry grinding etc. The rare earths are silver, silverywhite, or gray metals; they have a high luster, but tarnish readily in air, have high electrical conductivity. The rare earths share many common properties this makes them difficult to separate or even distinguish from each other. There are very small differences in solubility and complex formation between the rare earths. The rare earth metals naturally occur together in minerals. Rare earths are found with non metals, usually in the 3+ oxidation state. At present all the rare earth resources in India are in the form of placer monazite deposits, which also carry other industrially important minerals like ilmenite, rutile, zircon, sillimanite and garnet.

Some of the fundamentals of the book are commercially important rare earth minerals, exploration for rare earth resources, rare earth resources of the world, some rare earth minerals and their approximate compositions, rare earths in cracking catalysts, rare earth based phosphors, interdependence of applications and production of rare earths, uranium alloys, conversion of ores to lithium chemicals, characterization and analysis of very pure silicon, derivation of molybdenum metal, electroplating and chromizing, electrolytic production of titanium, heat treatment of titanium alloys, tensile properties of alloys etc.

The book covers occurrence of rare earth, resources of the world, production of lithium metals, compounds derived from the metals, chemical properties of beryllium, uses of selenium, derivation of molybdenum metals, ore concentration and treatment and many more. This is a unique book of its kind, which will be a great asset for scientists, researchers, technocrats and entrepreneurs.

Natural Abundance

Occurrence of Rare Earths

1. Placer Deposits
2. Vein Type Deposits
3. Bastnasite Deposits
4. Ion Adsorption Type Ores
5. Other Rare Earth Sources

Commercially important Rare Earth Minerals

1. Monazite
2. Bastnasite
3. Xenotime

Exploration for Rare Earth Resources

Rare Earth Resources of the world

1. China
2. United States of America
3. India

1. Beach Placers and Dunes
2. Inland Placers
3. Reserves of Monazite
4. Occurrence of Xenotime

4. Australia

1. Placer Deposits
2. Hard rock Deposits
1. Mount Weld Deposit
2. Mary Kathleen
3. Port Pirie
4. Olympic Dam
5. Brazil

Other countries

Table 1.

The Content of Rare Earths and Some Common Elements in the Igneous Rocks of the Earth's Crust

Table 2.

Some Rare Earth Minerals and their Approximate Compositions

Table 3.

Typical Placer Minerals and their Specific Gravity

Table 4.

Mineralogical Composition of Typical Placer Samples, as mined in India and Australia

Table 5.

Rare Earth Distribution in Various Rock Forming and Accessory Mineral of Host Rock

Table 6.

The Rare Earth Pattern in Different Layers of an Ion Adsorption Type Deposit

Table 7.

Composition of REO recovered from major Ion-Adsorption Type Deposits in China

Table 8.

The REO Content of Different Types of Ores in China

Table 9.

Analysis of the Typical Loparite Sample

Table 10.

Rare Earths Distribution in Monazite from Different Sources (wt %)

Table 11.

Rare Earth Distribution in REO from Bastnasite from different

Sources (wt. %)

Table 12.

Rare Earth Distribution in Xenotime Samples (wt.%)

Table 13.

Ore Types In Baiyunebo Deposit

Table 14.

Chemical Analysis of Ore Samples from Deposit no. 801, China

Table 15

Some Important Rare Earth Resources of Australia and their Rare Earth and Thorium content

Table 16

Countrywise Distribution of Rare Earth Resources

1. Arc Carbons

Glass Making Industry

1. Decolourization of glass

2. Colouring of glass

3. Special Glasses

1. Spectacle Glass

2. Television and Cathode Ray Tubes

3. Glass for Eye protection

4. Infrared Transmitting Glass

5. Radiation Protection Windows

6. Optical Glass

Laser Glass

Fibre

Glass Polishing Powders

1. Glass Polishing Technology

2. Different Types of Abrasives

3. Manufacturing Methods

4. Producers of Polishing Powders

4. Enamels and Glazes

Catalysts

1. Rare Earths in Cracking Catalysts .

1. Cracking Process

2. Evolution of the catalyst

3. Rare Earth, Exchange of the Zeolite

4. Composition of the catalyst

5. Role of Rare Earths in the Catalyst

Use of Rare Earth Zeolites

6. Rare Earth Consumption

7. Impact of Lead Additive Phase down

8. Scope for using cerium in FCC unit

2. Application of Cerium and Lanthanum in Auto-exhaust Catalysts

1. Catalyst Converter System

2. Role of Rare Earths

3. Other Catalyst Applications of Rare Earths

1. Methanation

2. Ammonia Synthesis

3. Homogenous Catalysis

4. Methane Conversion

Fine Ceramics

1. High Temperature Structural Ceramics

1. Stabilization of Zirconia

2. Sintering of Silicon Nitride (Si_3N_4)

3. Sintering of Silicon Carbide (SiC)
2. Functional Ceramics
 1. Piezoelectric Materials
 1. Role of REO in Piezoelectric Ceramics
 2. Applications of Piezoelectric Ceramics
 2. Optoelectronic Materials
 1. Applications
 2. Preparation of PLZT Materials
 3. Thermistor, Varistor and Capacitor Materials
 1. PTC Thermistor
 2. Varistor Materials
 3. Grain Boundary Barrier Layer (GBBL) Capacitors
 4. Solid Oxide Fuel Cells
 1. Electrolyte
 2. Electrodes
 3. Interconnecting Material
 5. Oxygen Sensors
 6. Heating Elements
 7. High Temperature Super-conducting Materials
- Rare Earth Based Phosphors
 1. General
 1. Laser Action
 2. Antistoke Emission
 2. Rare Earths as Phosphor Materials
 1. Fluorescence due to 4f Transitions
 2. Fluorescence due to Transitions from 5d to 4f Orbital
 3. Rare Earths as Phosphor Matrices
 3. Major Applications of Rare Earth Phosphors
 1. Low Pressure Mercury Lamps
 1. Desirable Phosphor Properties for Fluorescent Tubes
 2. Phosphors used in Tube Lights
 3. Rare Earth Phosphors in Fluorescent Tubes
 2. Rare Earths in High Pressure Mercury Vapour Lamps
 3. Trichromatic Compact Lamps
 1. Matching of Lamp Light to the Visual System
 2. Red Phosphor
 3. Green Phosphor
 4. Blue Phosphor
 5. Performance of the Trichromatic Lamp
 4. R&D in phosphor Development in India
 5. Preparation of Light Phosphors
 6. Application of Cathodoluminescence of Rare Earth
 1. Colour Television Phosphors
 2. Preparation of Phosphors
 7. Phosphors for Non-illumination Purposes
 8. Electroluminescent Phosphors
 9. Thermoluminescent Phosphors
 10. Rare Earth X-ray phosphors
 1. X-ray screens and scanners
 2. Advantage of Rare Earth Phosphors
 3. Rare Earth Compounds used in X-ray phosphors
 11. Rare Earths in other Medical Imagery
- Rare Earths in Nuclear Technology

9. Miscellaneous Applications

1. Application in Agriculture

1. Techniques of Application

2. Nong-le and N.P.K. Fertilizers

3. Areas of Application

2. Dyeing and Currying

3. Colouring of Plastics

Interdependence of Applications and Production of Rare Earths

Introductory

Particle Characteristics

Middlings

Table 1.

Types of Middling

Staged Concentration

Panning

Gravity Separation

Chemical Methods

Flotation

Magnetic and Electric Methods

Amalgamation

Exploitable Factors

Concentration Formulae

Preliminary

Crushing

Crushing Theory

Physical Aspects of Comminution

The Crushing Sequence

Jaw Crushers

Variations on the Blake

The Dodge Crusher

Gyratory Crushers

Comparison of Jaw and Gyratory Crushers

Mobile Crushing Units

By-passing the Undersize

Feeding Arrangements

Protective Devices

The Duty of the Section

Lay-out and Equipment

The Symons Cone Crusher

Gearless Gyratories

ROLLS

Hammer Mills

Gravity Stamps

Dry Crushers, Summarised

Optimum Grind

Applied Power

Useful or Net Power

Grinding and the Particle

Grinding Objectives

Comminution of Particles

Effect of Peripheral Speed

The Return Load

The Solid-Liquid Ratio

Control
Preliminary
Fixed-path Mills
The Vibrating Mill
Tumbling Mills
Operation
Application
Mill Capacity
General Conclusions
Preliminary
Milling Action
Types of Mill
The Hardinge Mill
The Low-discharge Cylindrical Mill
Tube, or High-discharge Mills
The Cascade Mill
Mill Liners
Feeding
Crushing Bodies
Capacity
Introduction
Isotopes and Nuclear Reactions
OCCURRENCE AND SOURCES
PRODUCTION AND ECONOMIC STATISTICS
CONCENTRATION FROM ORES
REFINING
PREPARATION OF METAL
PHYSICAL PROPERTIES
MECHANICAL AND METALLURGICAL BEHAVIOUR
Hardness
Elastic Properties
Tensile Properties
Creep
Fatigue
Deformation and Textures
Recovery, Recrystallization, and Grain Growth
RADIATION DAMAGE
CHEMICAL BEHAVIOUR: REACTIONS AND COMPOUNDS
Reactions with Nonmetallic Elements; Binary Compounds
Reactions with Simple Compounds of Nonmetallic Elements
Reactions with Aqueous Solutions
Uranium Alloys
Nonmetals: Carbon, Boron, and Silicon
Metals
Liquid Metals
Phase Diagrams
Table 13. Alloying Behavior of Uranium
Metallography
Melting and Casting
Forging
Rolling
Extrusion
Swaging and Drawing

Machining
Welding
Powder Metallurgy
USE OF URANIUM
In Nuclear Reactors
Other Uses
INTRODUCTION
OCCURRENCE
Cost Considerations
CONVERSION OF ORES TO LITHIUM CHEMICALS
Production of Lithium Metal by Fused Salt Electrolysis
PHYSICAL PROPERTIES AND HANDLING OF THE METAL
Lithium Cartridges
Lithium Wire or Ribbon
Lithium Shot
Sodium-Free Lithium Metal
Molten Lithium
COMPOUNDS DERIVED FROM THE METAL
Lithium and Hydrogen
Lithium and Nitrogen
Lithium and Oxygen
Lithium and Silicon
OTHER LITHIUM COMPOUNDS
Lithium Hydroxide
Lithium Halides
Various Other Lithium Compounds
ELECTROCHEMISTRY OF LITHIUM
Alloys
Lithium-Magnesium Alloys
Lithium-Aluminium Alloys
Lithium-Zinc Alloys
Lithium-Lead Alloys
USES OF LITHIUM METAL
Lithium in Alloys
Lithium as a Degasifier and Refining Agent
Lithium in Cast Iron
Lithium in Steels
Lithium in Organic Chemistry
Lithium in Atomic-Energy Developments
Lithium in High-Energy Fuels
USES OF LITHIUM COMPOUNDS
INTRODUCTION
OCCURRENCE
PRODUCTION AND ECONOMIC STATISTICS
DERIVATION
Copeaux-Kawecki Process
Sawyer-Kjellgren Process
PRODUCTION
Pure Beryllium Oxide
Beryllium Metal
Beryllium-Copper Master Alloy
PHYSICAL PROPERTIES
Beryllium

Beryllium Oxide

CHEMICAL PROPERTIES OF BERYLLIUM

TOXICITY

MECHANICAL PROPERTIES

Beryllium

Beryllium Alloys

FABRICATION

Beryllium

Beryllium-Copper Alloys

APPLICATIONS

Beryllium

Beryllium Oxide

Beryllium-Copper Alloys

Beryllium-Nickel Alloys

Beryllium-Iron Alloys

Miscellaneous Beryllium Alloys

INTRODUCTION

OCCURRENCE

DERIVATION

PHYSICAL PROPERTIES

The Solid State

The Liquid State

The Vapour State

Electrical Conductivity

Effect of Light on Electrical Properties of Selenium

CHEMICAL PROPERTIES

Oxygen

Hydrogen

Halogens

TOXICITY

USES OF SELENIUM

Electronics Industry

Glass and Ceramics Industry

Pigment Industry

Steel Industry

Miscellaneous Uses

INTRODUCTION

OCCURRENCE

PRODUCTION AND ECONOMIC STATISTICS

DERIVATION

Extraction of Platinum Metals from

Canadian Nickel Ores

Extraction of Platinum from South African Ores

Refining of Platinum Metal Concentrates

Treatment of Native Platinum

Refining of Scrap

FABRICATION TECHNIQUES

Melting

Working

Electrodeposition

Vapour Deposition

Available Forms

PHYSICAL PROPERTIES

Platinum
Palladium
Rhodium and Iridium
Ruthenium and Osmium
Alloys of the Platinum Metals
CHEMICAL PROPERTIES
Compact Metals
Sponge and Powdered Metals
"Blacks" and Colloidal Metals
APPLICATIONS

Platinum
Palladium
Rhodium
Iridium
Osmium
Ruthenium
History
Occurrence and Sources
Production and Price Statistics
Extraction
Production of Tantalum Metal
Consolidation and Purification
Physical Properties
Mechanical Properties
Chemical Properties
Alloys
Tantalum-Tungsten Alloys
Fabrication
Applications
Surgical
Nuclear Energy Systems
Miscellaneous

CALCIUM
Derivation
Physical Properties
Mechanical Properties
Applications
Calcium Hydride
Calcium Alloys

BARIUM

STRONTIUM

INTRODUCTION

OCCURRENCE

PRODUCTION AND ECONOMIC STATISTICS

DERIVATION

PHYSICAL PROPERTIES

CHEMICAL PROPERTIES

APPLICATIONS

SINGLE CRYSTALS

CHARACTERIZATION AND ANALYSIS OF VERY PURE SILICON

INTRODUCTION

OCCURRENCE

PRODUCTION AND STATISTICS

Prices

ORE PROCESSING

DERIVATION OF MOLYBDENUM METAL

Powder Metallurgy Process

Arc-Casting Process

WORKING OF MOLYBDENUM

PHYSICAL PROPERTIES

MECHANICAL PROPERTIES

Corrosion Resistance of Metallic Molybdenum

PROTECTION FROM OXIDATION

MOLYBDENUM COMPOUNDS

FABRICATION

JOINING

APPLICATIONS

Molybdenum as an Alloying Element

OCCURRENCE

PRODUCTION AND ECONOMIC STATISTICS

DERIVATION

PHYSICAL PROPERTIES

CHEMICAL PROPERTIES

FABRICATION

ALLOYS

APPLICATIONS

OCCURRENCE AND CHARACTERISTICS

USES OF CHROMIUM ORE

CHROMIUM METAL

Alumino- and Silicothermic Chromium

Carbon-Reduced Chromium

Electrolytic Chromium

PHYSICAL PROPERTIES OF CHROMIUM

Electronic Structure

Thermal Properties

CHEMICAL PROPERTIES

ANALYSIS OF CHROMIUM

CHROMIUM TOXICOLOGY

MELTING AND FABRICATION

MECHANICAL PROPERTIES

TENSILE PROPERTIES

TRANSITION TEMPERATURE

Electroplating and Chromizing

CHROMIUM ALLOY SYSTEMS

APPLICATIONS

INTRODUCTION

OCCURRENCE

PRODUCTION AND STATISTICS

DERIVATION

Initial Recovery

Purification

Recovery

Purification

PHYSICAL PROPERTIES

CHEMICAL PROPERTIES

Toxicity

ALLOYS

Binary Systems

Ternary Systems

FABRICATION TECHNIQUES

APPLICATIONS

INTRODUCTION

OCCURRENCE

HISTORICAL REVIEW

PROCESSES FOR MAKING BORON

PRODUCTION OF BORON 10

PHYSICAL PROPERTIES

CHEMICAL PROPERTIES

METHODS OF ANALYSIS

FABRICATION TECHNIQUES

APPLICATIONS

OCCURRENCE

PRODUCTION

EXTRACTIVE METALLURGY

Oxide Reduction

Magnesium Reduction of Titanium Tetrachloride

Sodium Reduction Titanium Tetrachloride

The Iodide Process

Electrolytic Production of Titanium

PHYSICAL AND MECHANICAL PROPERTIES

CHEMICAL PROPERTIES

Corrosion

Oxidation

Chemical Compounds

PHYSICAL METALLURGY

Alloying Principles

Heat Treatment of Titanium Alloys

Metallography

PROCESSING AND FABRICATION

Melting

Fabrication

APPLICATIONS OF TITANIUM

INTRODUCTION

OCCURRENCE

PRODUCTION AND ECONOMIC STATISTICS

METALLURGY

Ferrotungsten

Tungsten Compounds

Tungsten Metal

Reduction

Tungsten Carbide

PHYSICAL PROPERTIES

MECHANICAL PROPERTIES

CHEMICAL PROPERTIES

ALLOYS

Tungsten-Molybdenum, Columbium, Tantalum, Chromium

Tungsten-Rhenium

Tungsten-Iron

Tungsten-Cobalt

Tungsten-Nickel

Tungsten-Nickel-Copper

Tungsten Steels

Miscellaneous

ANALYSIS AND METALLOGRAPHY

FABRICATION

Ductile Rod and Wire

Tungsten Sheet

Slip Casting

Arc Casting

Electron Beam Melting

Hydrostatic Compacting

Flame Spraying

Sintered Carbide

APPLICATIONS

Present Applications

Potential Applications

INTRODUCTION

Sources of zirconium

ORE CONCENTRATION AND TREATMENT

Separation of Zirconium and Hafnium

PRODUCTION OF DUCTILE ZIRCONIUM METAL

Reduction of ZrO_2

Reduction of Zirconium Halides

Reduction of Other Compounds

Reduction of $ZrCl_4$ with Mg—the Kroll Process

Iodide Decomposition Process

Electrodeposition of Zirconium

Physical and mechanical properties

CHEMICAL PROPERTIES

Reaction with Gases

Reaction with Halogens

Miscellaneous

CORROSION RESISTANCE

Corrosion in Various Media

Corrosion in Gases

Corrosion in Liquid Metals

Corrosion in Other Media

MELTING ZIRCONIUM

FABRICATION

Rolling and Forging

Extrusion

Cold Working

Machining

Power Brake Forming

Surface Finishing

Welding

ZIRCONIUM-ALLOY SYSTEMS

Tensile Properties of Alloys

Zircaloy

APPLICATIONS

About NIIR

NIIR PROJECT CONSULTANCY SERVICES (NPCS) is a reliable name in the industrial world for offering integrated technical consultancy services. NPCS is manned by engineers, planners, specialists, financial experts, economic analysts and design specialists with extensive experience in the related industries.

Our various services are: Detailed Project Report, Business Plan for Manufacturing Plant, Start-up Ideas, Business Ideas for Entrepreneurs, Start up Business Opportunities, entrepreneurship projects, Successful Business Plan, Industry Trends, Market Research, Manufacturing Process, Machinery, Raw Materials, project report, Cost and Revenue, Pre-feasibility study for Profitable Manufacturing Business, Project Identification, Project Feasibility and Market Study, Identification of Profitable Industrial Project Opportunities, Business Opportunities, Investment Opportunities for Most Profitable Business in India, Manufacturing Business Ideas, Preparation of Project Profile, Pre-Investment and Pre-Feasibility Study, Market Research Study, Preparation of Techno-Economic Feasibility Report, Identification and Section of Plant, Process, Equipment, General Guidance, Startup Help, Technical and Commercial Counseling for setting up new industrial project and Most Profitable Small Scale Business.

NPCS also publishes various process technology, technical, reference, self employment and startup books, directory, business and industry database, bankable detailed project report, market research report on various industries, small scale industry and profit making business. Besides being used by manufacturers, industrialists and entrepreneurs, our publications are also used by professionals including project engineers, information services bureau, consultants and project consultancy firms as one of the input in their research.

Our Detailed Project report aims at providing all the critical data required by any entrepreneur vying to venture into Project. While expanding a current business or while venturing into new business, entrepreneurs are often faced with the dilemma of zeroing in on a suitable product/line.

NIIR PROJECT CONSULTANCY SERVICES, 106-E, Kamla Nagar, New Delhi-110007, India.
Email: npcs.india@gmail.com **Website:** NIIR.org

Fri, 09 May 2025 05:41:31 +0000