GENERAL

asm handbook properties and selection nonferrous alloys and special purpose materials asm handbook vol 2

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Introduction

When engineers, designers, and materials scientists face the daunting task of selecting the right metal for a new component, the **ASM Handbook properties and selection nonferrous alloys and special purpose materials ASM Handbook vol 2**becomes an indispensable reference. This volume, part of the renowned ASM International series, compiles comprehensive data, practical guidelines, and expert insights into the performance of nonferrous alloys and a wide array of special purpose materials. Whether you're working in aerospace, automotive, electronics, or biomedical fields, understanding how to navigate this handbook can save time, reduce costs, and ensure that your final product meets all required specifications.

What Is the ASM Handbook?

History and Editions

The ASM Handbook series has been a cornerstone of materials science literature since its inception in the mid 20th century. Published by ASM International, the series covers every aspect of materials engineering, from metallurgy to mechanical testing. Each volume is meticulously curated by experts in the field, ensuring that the information remains current and scientifically rigorous.

Volume 2 Focus

ASM Handbook Volume 2 is dedicated specifically to the **properties and selection of nonferrous alloys and special purpose materials**. Unlike the more general volumes that cover ferrous alloys or processing techniques, Volume 2 dives deep into the unique characteristics of copper, aluminum, magnesium, titanium, nickel, zinc, and other non steel metals. It also includes a wide range of advanced materials such as high temperature alloys, corrosion resistant steels, and biocompatible metals that are crucial in modern engineering applications.

Overview of Nonferrous Alloys

Definition and Classification

Nonferrous alloys are metal alloys that contain little or no iron. They are prized for their high strength-to-weight ratios, excellent corrosion resistance, and unique electrical or thermal properties. Common categories include:

- Copper Alloys – e.g., brass, bronze, and copper tin alloys.
- Aluminum Alloys – e.g., 2000, 3000, 5000, 6000, and 7000 series.
- Magnesium Alloys – e.g., AZ, AM, and WE series.
- Titanium Alloys – e.g., Ti 6Al 4V, Ti 6Al 2Sn 4Zr 2Mo.
- Nickel Alloys – e.g., Inconel, Hastelloy, Monel.
- Zinc Alloys – e.g., Zamak, ZK series.

Key Properties

When evaluating nonferrous alloys, engineers typically consider:

1. Mechanical Strength – ultimate tensile strength, yield strength, and elongation.
2. Corrosion Resistance – susceptibility to oxidation, pitting, and galvanic corrosion.
3. Thermal Conductivity – important for heat exchangers and thermal management.
4. Electrical Conductivity – critical for electrical components.
5. Processing Ease – formability, weldability, and machinability.
6. Cost and Availability – raw material prices and supply chain considerations.

Special Purpose Materials

Definition

Special purpose materials are engineered to meet specific performance criteria that cannot be satisfied by conventional alloys. These materials often combine multiple elements or incorporate microstructural modifications to achieve exceptional properties.

Categories

- High Temperature Alloys – e.g., Inconel, Haynes, and Hastelloy for turbine blades.
- Corrosion Resistant Alloys – e.g., Monel, Hastelloy C, and duplex stainless steels.
- High Strength Alloys – e.g., Ti 6Al 4V, Ti 6Al 2Sn 4Zr 2Mo, and certain nickel based superalloys.
- Lightweight Alloys – e.g., magnesium alloys, aluminum lithium alloys.
- Magnetic Materials – e.g., permalloy, silicon steel.
- Biocompatible Alloys – e.g., Ti 6Al 4V, NiTi (shape memory alloys).

Chapter Highlights from ASM Handbook Volume 2

Chapter 1: General Principles

This introductory chapter outlines the fundamental concepts of alloy design, including phase diagrams, thermodynamic principles, and the impact of alloying elements on material behavior. It establishes the framework for the rest of the handbook.

Chapter 2: Copper Alloys

Detailed tables of mechanical properties, corrosion data, and processing guidelines are provided for common copper alloys such as brass, bronze, and copper tin alloys. The chapter also covers surface treatments like anodizing and electroplating.

Chapter 3: Aluminum Alloys

Aluminum alloys are presented in a series by series format, with comprehensive data on strength, fatigue, corrosion, and weldability. Special sections discuss the effects of heat treatment and precipitation hardening.

Chapter 4: Magnesium Alloys

Magnesium alloys, prized for their low density, are evaluated for mechanical performance and corrosion resistance. The chapter includes guidelines for extrusion, forging, and additive manufacturing.

Chapter 5: Titanium Alloys

Titanium alloys are highlighted for their high strength, corrosion resistance, and biocompatibility. The chapter covers Ti 6Al 4V, Ti 6Al 2Sn 4Zr 2Mo, and other grade specific data.

Chapter 6: Nickel Alloys

Nickel alloys, including Inconel, Hastelloy, and Monel, are analyzed for high temperature performance, corrosion

resistance, and weldability. The chapter also discusses alloy selection for corrosive environments.

Chapter 7: Zinc Alloys

Zinc alloys are presented with emphasis on castability, machinability, and corrosion resistance. Zamak alloys, commonly used in die casting, are covered in detail.

Chapter 8: Special Purpose Materials

This chapter provides a comprehensive overview of materials tailored for specific applications, such as high temperature superalloys, corrosion resistant alloys for chemical processing, and biocompatible alloys for medical implants.

Chapter 9: Processing and Fabrication

Guidelines for casting, forging, extrusion, machining, welding, and additive manufacturing are consolidated here, along with common defects and troubleshooting strategies.

Chapter 10: Testing and Standards

Testing methods for mechanical, thermal, and corrosion properties are described, along with references to ASTM, ISO, and other industry standards.

How to Use the Handbook for Selection

Step by Step Process

1. Define Requirements: Identify mechanical, thermal, electrical, and environmental criteria.
2. Screen Candidate Materials: Use the handbook's tables to filter alloys based on primary properties.
3. Evaluate Secondary Factors: Consider corrosion resistance, weldability, and cost.
4. Perform Trade off Analysis: Compare candidate alloys against the full spectrum of requirements.
5. Validate with Prototyping: Fabricate test specimens and conduct real world testing.
6. Finalize Selection: Choose the alloy that best balances performance, cost, and manufacturability.

Example Selection

Suppose an aerospace engineer needs a lightweight, high strength material for a turbine blade that must withstand temperatures up to 1000 °C and resist oxidation. By consulting Volume 2, the engineer might shortlist Ti 6Al 4V for its excellent high temperature strength and Inconel 718 for its superior oxidation resistance. Further analysis of cost, availability, and manufacturing constraints would guide the final choice.

Common Nonferrous Alloys Covered

Copper and Copper Alloys

Copper alloys are celebrated for their excellent electrical conductivity and corrosion resistance. Brass (Cu Zn) offers a good balance of strength and formability, while bronze (Cu Sn) provides superior wear resistance and low friction.

Aluminum Alloys

Aluminum alloys are classified by alloying elements:

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