

Chapter 1

Innovative Materials in General

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1. Introduction

- The **advancement** of materials is a **key** area of scientific research and technological **innovation**.
- It **includes** the study, development, design and application of **new** materials, as well as the **improvement** of **existing** materials.
- This **progress** certainly leads to the "**creation**" of so-called "**innovative**" materials.
- These materials are **constantly** being **developed**. Advances in innovative materials enable us to **create** products that **perform** better, last **longer** and are more **respectful** of the environment.
- These advances are generally the **result** of scientific **discoveries**, **new** manufacturing technologies, **interdisciplinary** collaborations and significant **investment** in research and **development**.
- Innovative materials **open** the way to new **opportunities** and **innovative** solutions for current and future challenges.

2. Definition

What is an Innovative Material ?

- An innovative material is one that offers new and advanced properties, characteristics or applications compared to traditional materials. These materials are generally the product of scientific research and technological development aimed at improving or pushing back the limits of existing materials.

In french : Un matériau innovant est un matériau qui présente des propriétés, des caractéristiques ou des applications nouvelles et avancées par rapport aux matériaux traditionnels. Ces matériaux sont généralement le produit de recherches scientifiques et de développements technologiques visant à améliorer ou à repousser les limites des matériaux existants.

3. Characteristics of innovative materials

What are their characteristics ?

- The characteristics of innovative materials can include properties such as : lightness (légèreté), strength (résistance), electrical conductivity, thermal conductivity, biocompatibility, chemical reactivity, flexibility, transparency, high-temperature resistance, durability, self-repair, and so on.
- These properties are often exploited to create new products, improve existing technologies or solve specific problems.

4. Use of innovative materials

What are they used for ?

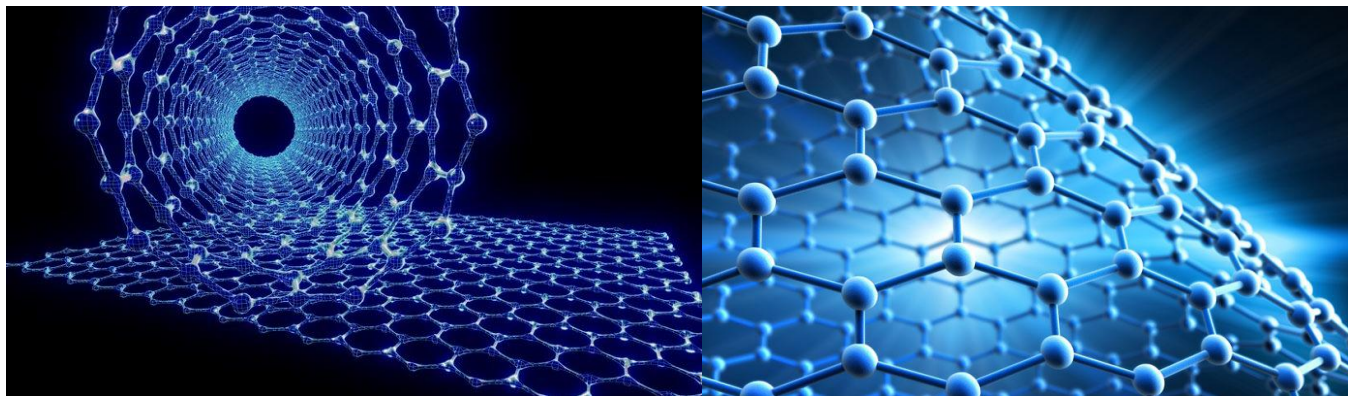
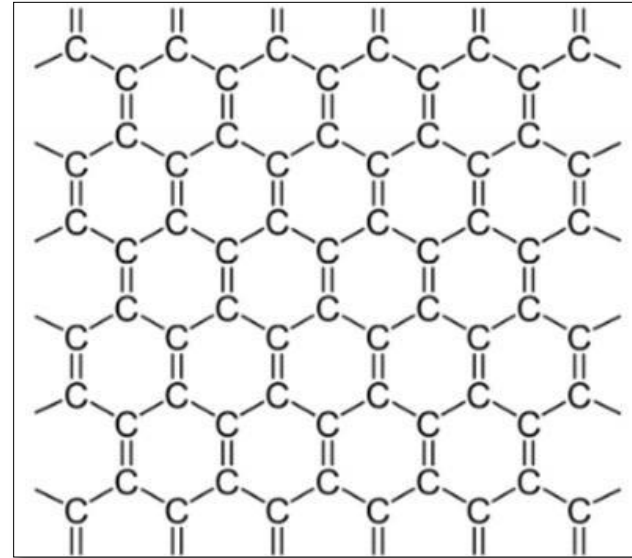
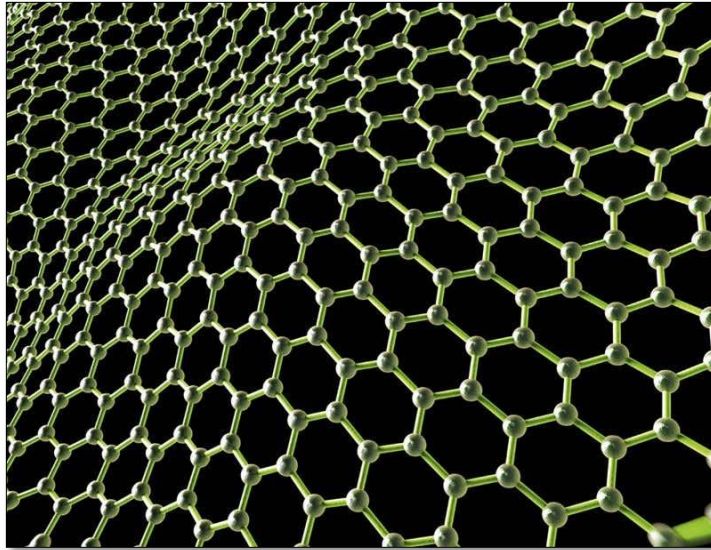
- Innovative materials are widely used in many fields, including aerospace, automotive, electronics, medicine, construction, energy, the environment and many others.
- They enable us to design products that are more efficient, more durable, better performing and more respectful of the environment.

5. Example of innovative materials

Can we get an example of innovative materials ?

- An **excellent** example of an innovative material is **graphene**,
- Graphene is a material consisting of a **single** layer of carbon atoms arranged in a hexagonal structure.
- Graphene has **extraordinary** properties in terms of **electrical** conductivity, thermal **conductivity**, **lightness** and **strength**, making it a **highly innovative** material with a wide range of potential **applications**.

Example of an innovative material is graphene



Graphene is a single layer of carbon atoms arranged in a two-dimensional honeycomb lattice. It is known for its exceptional strength, conductivity, and flexibility, making it a promising material for various applications.

6. Objective

What can be as objectif of the innovative materials

- Innovative materials are essential for :
 - the advancement of technology ;
 - help to solve major challenges in many areas of science and industry.

- They are the driving force behind
 - innovation
 - research in the modern world.

7. Innovative materials in metallurgy (Matériaux innovant en métallurgie)

In metallurgy, materials innovation is essential to improve the performance of metals, alloys and production processes.

1. *High-performance alloys (Alliages à haute performance) :*

Innovative metal alloys are designed to be stronger, lighter and more durable, making them suitable for applications such as aerospace, automotive and the oil industry.

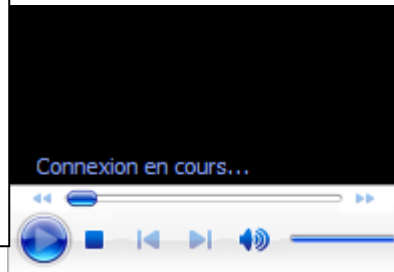
1. Superelastic alloy (Inconel) ;
2. Copper-aluminium-nickel shape memory alloy ;
3. Magnesium-based alloys ;
4. Titanium-based alloys ;
5. Rare-metal alloys ;
6. Refractory alloys ;
7. Copper alloys ;

a. Shape memory alloy (Nitinol):

Nitinol is an alloy of nickel and titanium that has the ability to return to its original shape after being deformed.



Shape memory alloy (Nitinol)



<https://www.youtube.com/shorts/4LFC9PTnKhA?feature=share>

b. Superelastic alloy (Inconel):

Inconel alloys, based on nickel and chromium, offer excellent resistance to heat, corrosion and high elasticity.

c. Copper-aluminium-nickel shape memory alloy:

This alloy is used in thermal control systems and automatic switches in response to temperature variations, for example, in thermostats.

d. Magnesium-based alloys:

Magnesium alloys, such as AZ91, are lightweight and corrosion-resistant. They are used in the automotive industry to reduce vehicle weight.

e. Titanium-based alloys:

Titanium alloys, such as Ti-6Al-4V, are lightweight and corrosion-resistant. They are widely used in aerospace, prosthetics and medical implants.

f. Rare-metal alloys:

Alloys that incorporate rare elements, such as terbium, dysprosium or neodymium, are used in permanent magnets, electric motors and clean-energy technologies.

g. Refractory alloys:

Refractory alloys, such as molybdenum-tungsten, are used in high-temperature environments, such as vacuum furnaces and aerospace applications.

h. Copper alloys :

such as Cupronickel, are corrosion-resistant and are used in cooling systems, hydraulic systems and marine applications.

Propriétés et Applications de quelques alliages à hautes performances

1. Alliages à base de nickel (Inconel, Hastelloy) :

- *Applications* : Industrie chimique, aérospatiale, pétrolière et gazière, nucléaire.
- *Propriétés* : Résistance à la corrosion, haute résistance mécanique à des températures élevées.
- *Exemple* :

2. Nickel-based alloys (Inconel, Hastelloy):

- *Applications: Chemical industry, aerospace, oil & gas, nuclear.*
- *Properties: Corrosion resistance, high mechanical strength at elevated temperatures.*
- *Example*



Nickel Alloy Inconel 625hastelloy B-2 X C-22 C-276 Plate Sheet Application for Offshore and Oil and Gas Components Industrial Aviation Chemical



Nickel Alloy
Ni200/201hastello...
US \$18-30 / kg



Nickel Alloy Ni200
Hastelloy B X C-22...
US \$18-30 / kg



Nickel Alloy Ni200
C-276 Plate Sheet...
US \$18-30 / kg



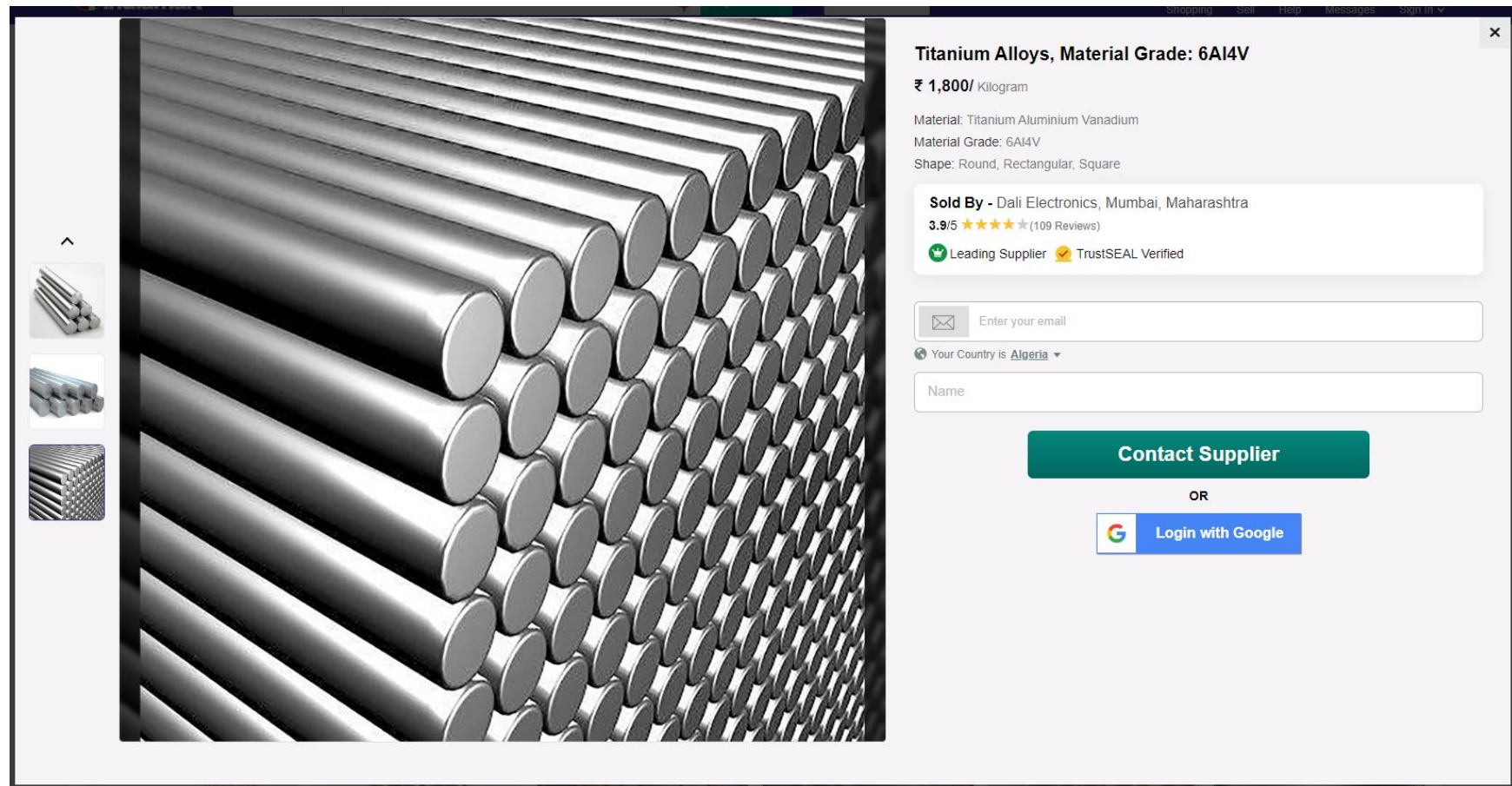
Nickel Alloy Pure Ni
Hastelloy B X C-22...
US \$18-30 / kg



Nickel Alloy Ni200
Hastelloy B X C-22...
US \$18-30 / kg

3. Titanium alloys :

- *Applications: Aerospace, biomedical, military.*
- *Properties: Low density, high strength, corrosion resistance.*
- *Example*



Titanium Alloys, Material Grade: 6Al4V

₹ 1,800/ Kilogram

Material: Titanium Aluminium Vanadium
Material Grade: 6Al4V
Shape: Round, Rectangular, Square

Sold By - Dali Electronics, Mumbai, Maharashtra
3.9/5 ★★★★★ (109 Reviews)
Leading Supplier TrustSEAL Verified


Enter your email

Your Country is **Algeria**

Name

Contact Supplier

OR

 **Login with Google**

4. Cobalt-based superalloys : Superalliages à base de cobalt :

- *Applications: Gas turbines, aerospace industry, medical prostheses, Marine, Oil and Gas, automotive ...*
- *Properties: High resistance to heat, oxidation and corrosion.*
- *Example*

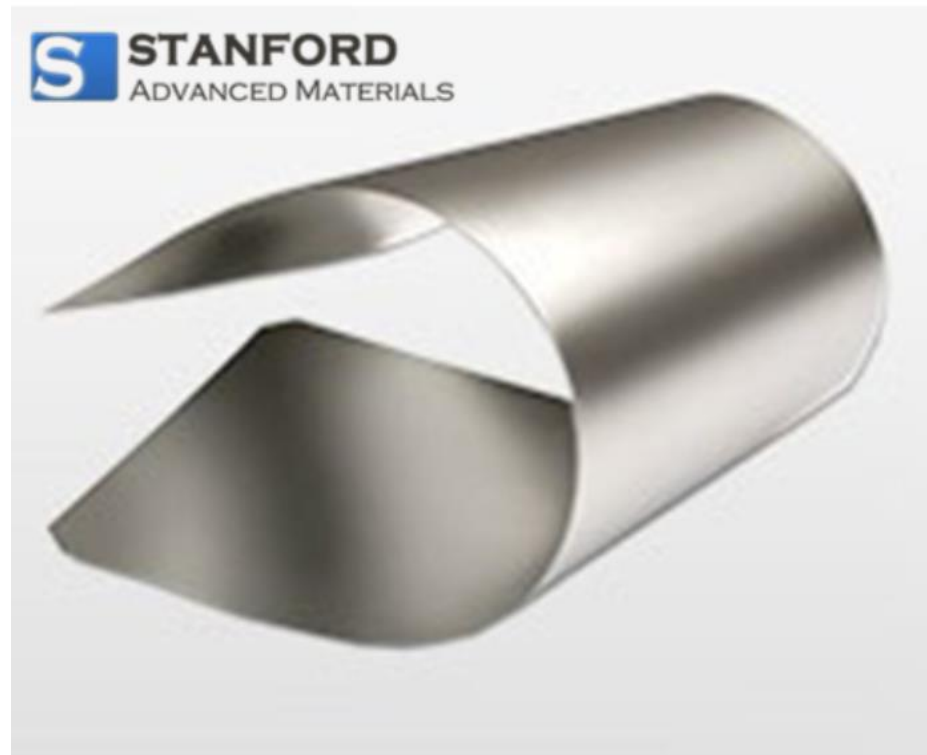


5. Shape memory alloys (Ni-Ti, Cu-Al-Ni): Alliages à mémoire de forme (Ni-Ti, Cu-Al-Ni) :

- *Applications : Medical devices, aerospace, electronics.*
- *Properties: Ability to return to a predefined shape after deformation, excellent elasticity.*

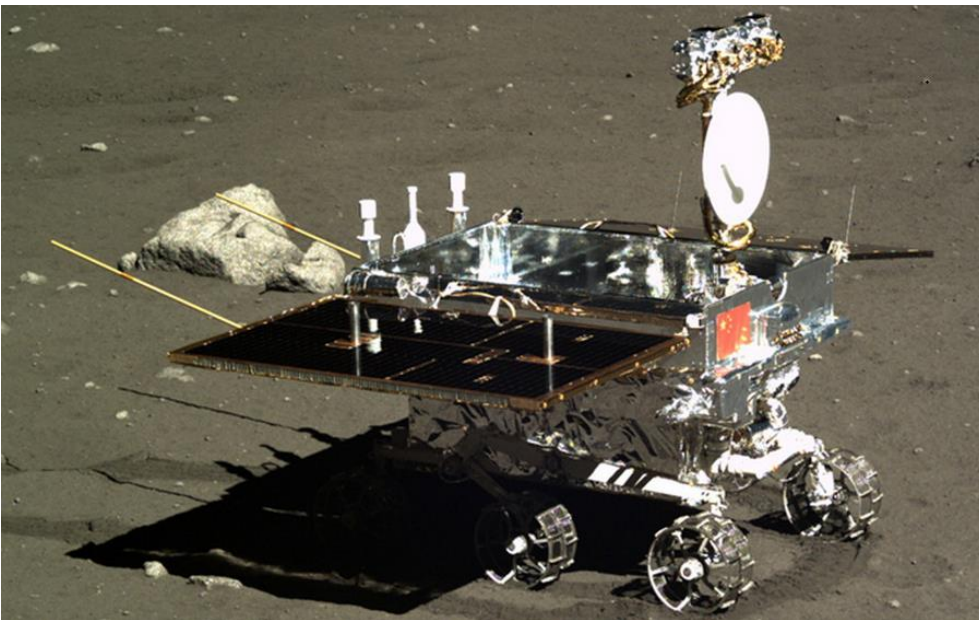
NT0408 Ti-Ni-Cu & Ti-Ni-Nb Shape Memory Alloy

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6. Tungsten-based alloys : Alliages à base de tungstène

- *Applications: Electronics, hard metals industry, aerospace.*
- *Properties: High density, corrosion resistance, high melting point.*

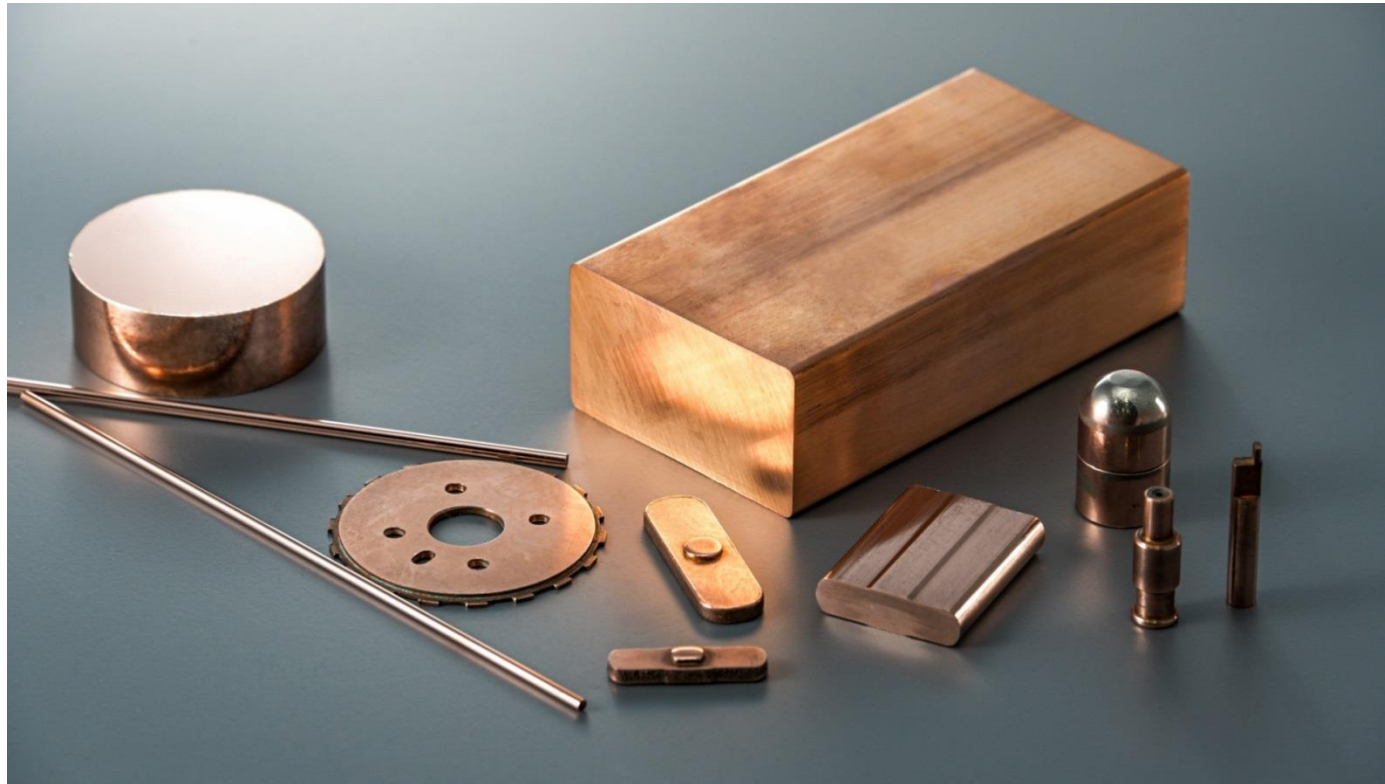




7. Dispersion-strengthened aluminum alloys (Duralumin): Alliages d'aluminium renforcés par dispersion (Duralumin)

- *Applications: Aerospace, light construction.*
- *Properties: Low weight, corrosion resistance, mechanical strength.*

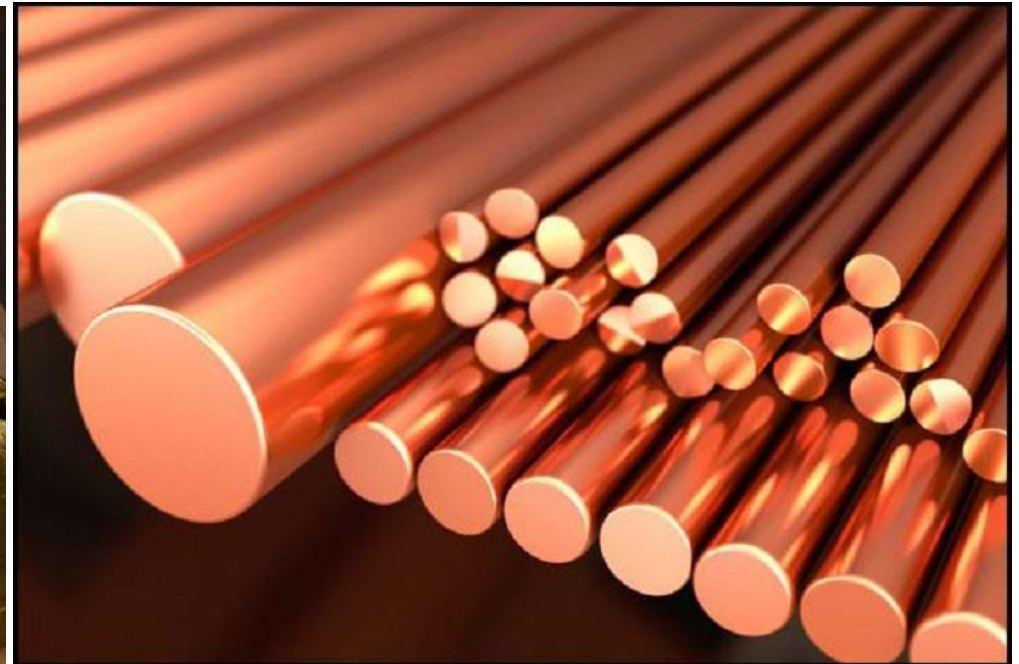
Aluminum oxide dispersion strengthened copper



<https://www.kansaipipe.co.jp/en/products/aluminum-oxide-dispersion-strengthened-copper/>

8. Copper-based alloys (Beryllium-Copper): Alliages à base de cuivre (Béryllium-cuivre)

- *Applications: Electronics, measuring tools, space equipment.*
- *Properties: High electrical conductivity, corrosion resistance, high hardness.*



AA series of **beryllium copper alloys** can be formed by dissolving about 2% of **beryllium** in copper

<https://www.refractorymetal.org/uses-of-beryllium-copper-alloys/>



These high-performance alloys are the result of advanced metallurgical engineering aimed at optimizing the specific properties required for particular applications. They play an essential role in the development of advanced technologies and in solving complex technical challenges.

Ces alliages à haute performance sont le résultat d'une ingénierie métallurgique avancée visant à optimiser les propriétés spécifiques nécessaires à des applications particulières. Ils jouent un rôle essentiel dans le développement de technologies avancées et dans la résolution de défis techniques complexes.