

## Appendix 1

### Copper: never ending recycling



#### Chemistry and Copper

<b>Group</b>	11	<b>Melting point</b>	1084.62°C, 1984.32°F, 1357.77 K
<b>Period</b>	4	<b>Boiling point</b>	2560°C, 4640°F, 2833 K
<b>Block</b>	d	<b>Density (g cm<sup>-3</sup>)</b>	8.96
<b>Atomic number</b>	29	<b>Relative atomic mass</b>	63.546
<b>State at 20°C</b>	Solid	<b>Key isotopes</b>	63Cu , 65Cu
<b>Electron configuration</b>	[Ar] 3d <sup>10</sup> 4s <sup>1</sup>	<b>Atomic radius, non-bonded (Å)</b>	1.96
<b>Electron affinity (kJ mol<sup>-1</sup>)</b>	119.159	<b>Electronegativity (Pauling scale)</b>	1.90
<b>Ionization energies (kJ mol<sup>-1</sup>)</b>	<b>1st</b>	<b>2nd</b>	<b>3rd</b>
	<b>745.482</b>	<b>1957.919</b>	<b>3554.616</b>

The copper element is in the same periodic table group as silver and gold. Therefore, it is relatively inert against chemicals. In most of its compounds it can have the valency (oxidation state) of +I or the valency state +II. The aqueous solutions of copper ions in the oxidation state +II have a blue color, whereas copper ions in the oxidation state +I are colorless. Copper and copper compounds give a greenish color to a flame.

#### Mechanical properties

The primary mechanical properties of copper—hardness, strength and ductility—determine its condition. The material condition (alternative term: temper) is designated in standards either by the letter H, representing a minimum hardness, or the letter R, representing a minimum tensile strength.

The strength and hardness of copper can also be increased by alloying, but this results in a decrease in electrical conductivity. The strongest copper alloy of all is produced by alloying with beryllium, followed by an age hardening heat treatment resulting in a tensile strength of up to 1500 N/mm<sup>2</sup>.

#### Electrical conductivity

The generation, transmission and use of electricity has transformed the modern world. This has been made possible by copper (of at least 99.9% purity), which has the best electrical conductivity of any common metal – one of the more well-known physical properties of copper. It is available in wrought form as wire, cable, strip and busbars and as castings for such components as electrical switchgear and welding equipment.

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### Thermal conductivity

Copper is a good conductor of heat (about 30 times better than stainless steel and 1.5 times better than aluminum). This leads to applications where rapid heat transfer is required such as heat exchangers in air conditioning units, vehicle radiators, heat sinks in computers, heat sealing machines and televisions, and as water-cooled furnace components.

### Copper and the Circular Economy

**Copper can be 100% recycled without any loss in performance.** As such, copper is a sustainable material that is pivotal to building the circular economy.

#### Make

**Responsible mining and successful recycling help make copper sustainable and resource-efficient.**

Copper used in the EU is mainly imported from Chile, Peru, Australia and the USA, though there is also some production in Europe, including Finland, Poland, Spain and Sweden.

Copper mining provides many valuable by-products that can be used in advanced material applications, including cobalt, molybdenum, rhenium, selenium, tellurium and rare earth elements, as well as silver, tungsten, gold, lead and zinc.

#### Use

**Copper is the metal of the energy transition, powering renewable energy systems and green technologies.**

Renewable energy systems use up to 12 times more copper than conventional power systems. Copper also typically improves energy efficiency. One ton of copper used in rotating machines—such as an electric motor or a wind turbine—saves 7,500 tons of CO<sub>2</sub> emissions over its lifetime.

Copper consumption is predicted to rise more than 40% by 2035. Partly driven by green technologies—like solar and wind power, and electric vehicles—additional demand will be met through mining and recycling.

#### Return

Copper can be recycled repeatedly without any loss of performance, and recycling requires up to 85% less energy than primary production.

Globally, this saves 40 million tons of CO<sub>2</sub> annually.

Europe already leads the world when it comes to copper recycling, with nearly 50% of its copper demand currently met by recycled material. The industry is now working to go even further.

