COPPER AND IT’S WINNING CHARACTERISTICS

• Long life-time
  Often lasting 200 years or more, there are some copper roofs which are around 350 years old.

• Formability
  Copper can easily be formed mechanically or by hand, on site or in the workshop, to suit virtually any three
  dimensional shape - including complex curves and details.

• Maintenance free
  A copper roof or facade needs no special maintenance.

• Temperature and weather resistant
  This means a very long service life. Copper is ideal for cold climate conditions and places where temperature
  variations are high as it does not break when worked/formed.

• Natural beauty and variable surfaces
  Available in many shades of colour from natural orange-red to brown and green as well as many lively
  surfaces.

• Durable and fire safe
  Copper doesn’t change its properties over time, resists sunshine, UV rays, water, humidity and is
  non-combustible.

• 100% recyclable again and again without loss of performance
  Saves natural resources and maintains its value.

• Essential for all life
  Copper is a naturally occurring element; it is present in the earth’s crust. All life needs copper to function
  properly.

• Copper has low embedded CO₂ ...
  The copper industry is at the forefront of industries committed to reducing the environmental impact of its ope-
  rations. For more information on copper life cycle data please visit www.copper-life-cycle.org.
COLOUR AND PATINA

The natural development of patina is one of copper’s unique characteristics: exposed to the outside atmosphere it protects itself by developing a patina layer over time which makes it weather resistant with a lifespan over many generations.

Changes are very gradual and not entirely predictable – just like the weather, which, in turn, is solely responsible for copper’s continual changes. The prevailing concentrations of air pollution and the environmental conditions essentially determine the composition and protective properties of the patina. The interaction of the patina with the local atmospheric conditions will determine the surface appearance and how it changes over time.

TYPICAL SURFACE APPEARANCE EVOLUTION OF COPPER AND COPPER ALLOYS USED IN ARCHITECTURE

- **Copper**
  Within a few days of exposure to the atmosphere surface begins to oxidise, changing its colour to chestnut brown which gradually darkens over several years and later may become a typical green patina.

- **Brass**
  An alloy of copper and zinc. The original shiny surface changes through from initial matting gradually to a greenish-brown that further develops to greys brown then dark brown/antracite colours. Sloped areas ultimately may develop a patina surface akin to that of pure copper, yet quite clearly different.

- **Bronze**
  An alloy of copper and tin. The original warm reddish-brown surface develops in a distinctive manner through weathering. A brown-red surface oxidation within a brown-grey undertone is typical for this alloy; the material then gradually changes to dark brown antracite throughout - the subsequent patina coating forms much more slowly than with pure copper.

- **Golden Alloy**
  This golden material is an alloy of copper with aluminium and zinc, which is very stable and keeps its golden shade over time. It behaves differently to pure copper in the environment as it has a thin protective oxide layer containing all three alloy elements when produced. As a result, the surface retains its golden colour indefinitely and simply loses some of its sheen as the oxide layer thickens with exposure to the elements, giving a matt gold coloured appearance.

To see more examples how copper & copper alloy clad buildings change their visual appearance over time go to weathering.copperconcept.org

Photo 6, 7: Dabas, Hungary
Market Hall
Architect: Kiss Járomi Építésziroda
Copper Product: Copper
Completion year: 2011
Photos: ECI
Photos taken: 05.2011 and 11.2016 (weathered)

To see more examples how copper & copper alloy clad buildings change their visual appearance over time go to weathering.copperconcept.org

Paris, France
Conservatoire Claude Debussy
Architect: Basalt Architecture
Completion year: 2013
Photos: Edgar Stouvenot - AvantagesWeb
Photo: Edgar Stouvenot - AvantagesWeb
Photo: Basalt Architecture architects / Sergio Grazia

The Copper Concept
www.copperconcept.org
HELSINKI
FINLAND
MERIPAVILJONKI
Architects: Arkkitehtitoimisto Freese Oy
Completion year: 2014

TURKU
FINLAND
ST HENRY CHAPEL
Architects: Sanaksenaho Arkkitehdit Oy
Completion year: 2003

Photos: Esko Tuomisto

Photos: Pyhä Henrik

Photo: ECI
AHRENSHOOP
GERMANY
MUSEUM OF ART
Architects: Snab Architekten
Completion year: 2013
Photos: Christian Richters / KME

copperconcept.org/en/references/kunstmuseum-ahrenshoop-germany

HARD
AUSTRIA
HOTEL AM SEE
Architects: FRÜHARCHITEKTURBÜRO ZT GMBH
Completion year: 2011
Photos: Christine Andorfer

2011
2014
2016
2016
2016
2011
BRASS
BRASS
BRASS

10 WEYMOUTH STREET
LONDON
UK
Completion year: 2009

Architects: Make

10 WEYMOUTH STREET
LONDON
UK
Completion year: 2009

Architects: Schmidt Hammer Lassen /
Pollard Thomas Edwards Architects

BRONZE

GRANARY BUILDING
LONDON
UK
Completion year: 2011

Architects: Schmidt Hammer Lassen / Pollard Thomas Edwards Architects
**GOLDEN VENDÉE FRANCE**

Tour des Arts des Herbiers

Architects: Forma 6, Nantes

Completion year: 2010

Photo: Edgar Stouvenot - AvantagesWeb


**GOLDEN PERFORATED LONDON UK**

Tidemill Academy

Architects: Pollard Thomas Edwards Architects

Completion year: 2012

Photo: Chris Hodson

[copperconcept.org/en/references/deptford-lounge-london-uk](copperconcept.org/en/references/deptford-lounge-london-uk)
**SCIENTIFIC STUDY**

The European copper industry has invested in understanding the surface appearance of copper based materials in different conditions and supports the research work carried out by the KTH Royal Institute of Technology, Surface and Corrosion Science in Stockholm. The on-going study is a long-term project that aims at assessing and generating a comprehensive understanding of atmospheric corrosion processes of copper and copper-based alloys used in building applications. Copper and three copper alloys (brass, bronze and golden alloy) have been exposed at unsheltered conditions at four test sites in Brest, France, representing four distances from the coastal line.

The way the protective patina forms, its thickness and composition largely influence the visual appearance of the material. Scientific results confirm that the level and how rapid the surface appearance change depend primarily on:

- **air quality & weather conditions:** the concentration of air pollutants, deposition of particles and prevailing weather conditions largely influence the patina composition,
- **distance from the sea:** materials close to marine splash areas will develop a green hue quite quickly, whereas materials placed in urban environments may tend towards a dark brown hue,
- **alloy composition,**
- **surface inclination and orientation.**

Selected postcards from the KTH study show changes in surface appearance after 6 months, three and five years in different locations exposed at inclinations relevant for roofing (45 degrees) and facades (90 degrees) for four different copper based materials: Natural Copper, Brass, Bronze and Golden alloy.

**Locations:**

- **Marine:** Exposure site St Anne, 25m distance from sea shore, high corrosivity level environment
- **Inland:** Exposure site Langonnet, 66km distance from sea shore, moderate corrosivity level environment

The pictures shown are for illustrative purposes only and should not be considered as exact representation of colour or visual changes in all situations or all time frames.

For full information on the KTH study download "Surface appearance of copper-based materials at unsheltered marine conditions" from copperconcept.org/en/publications

All photos on pages 14-15 are copyright KTH Royal Institute of Technology, Surface and Corrosion Science. e-mail: ingero@kth.se  
website: https://www.kth.se/profile/ingero/
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