



AURUBIS
ARCHITECTURAL

NORDIC COPPER
surfaces / forms / systems
realising your designs in copper

 **Aurubis**



Aurubis Copper Architecture

Aurubis is the largest producer of copper in Europe, with over 140 years experience, and is a world leader in copper recycling. The name Aurubis is based on the Latin for 'red gold' – reflecting the outstanding importance of copper since civilisation began.

Aurubis Architectural is a division of the company resulting from the purchase in 2011 of Luvata Rolled Products, formerly Outokumpu – which started producing copper products for roofs, facades and other applications in 1940. Aurubis Architectural is committed to developing this long heritage in copper architecture and its Nordic brands, working in partnership with designers.

Copper Architecture

Copper was one of the first metals used by man and is one of our oldest building materials, with unique properties and characteristics. With the twentieth century and international modern movement came a transformation from copper's historic role as a durable roofing material to a flexible architectural skin over any surfaces including walls. The malleability of copper sheet allows it to be used as a covering for architectural elements of all shapes with minimal constraints. Surfaces can be flat, curved or faceted and used at any inclination or pitch, and in any environment. As a result, modern architects focused on copper as a comprehensive wrapping to express building form and maintain material continuity.

Tampere City Library (Metso), Finland, is an exuberant demonstration of copper's potential for freedom of architectural form, from the latter part of the 20th century.

Architects: Reima and Raili Pietilä

Architects continue to exploit this capability today, fired by the complex shapes made possible by computer aided design techniques. But, with the move to postmodernism and beyond, many designers have also been keen to explore new manifestations of copper – very much as part of the dynamics of contemporary architecture and with a real sense of freedom.

Realising Designs in Copper

This brochure provides an introduction to the architectural opportunities and unrivalled freedom that architects can enjoy by working in partnership with us to realise their designs in copper, no matter how innovative. It explores how Aurubis Architectural redefines copper for contemporary design with the ongoing development of **surfaces, forms and systems** – not as a prescribed range of products to select from, but rather a source of inspiration for architects and the starting point for a creative partnership with us.

Our expertise and personal service are essential to developing your architectural visions in copper and we welcome an early involvement with your projects. Our website resource www.aurubis.com will provide contacts, more detailed information and interactive tools to help you at each stage in the design and specification process.

The complex building form of the Svalbard Science Centre (Architects: Jarmund/Vignæs), designed as a direct response to the extreme wind and snow demands of its environmentally sensitive Arctic location, could only have been achieved in copper.

Aurubis Copper – Characteristics

Aurubis' products for architectural applications such as facades and roofs use phosphorus deoxidised copper, designated Cu-DHP and complying with EN 1172:1997 – 'Copper and Copper Alloys: Sheet and Strip for Building Purposes'. This pure and natural material exhibits a unique range of characteristics and performance benefits including:

- ▶ Protection by its patina against corrosion in any atmospheric conditions, durable and problem-free with no maintenance.
- ▶ Exceptional, indefinite lifespan demonstrated over hundreds of years, and no underside corrosion issues.
- ▶ Light weight as a flexible covering for any building elements, saving on structure and delivering low 'whole of life' costs.
- ▶ Easily formed at any temperature without becoming brittle in cold weather.
- ▶ Low thermal movement and high melting point avoiding stretching in hot weather.
- ▶ Non-toxic and safe to work, with impressive antimicrobial qualities ideally suited to touch surfaces inside buildings.

The impressive sustainability and environmental credentials of copper have been clearly demonstrated in the past. Although the copper industry is well-known for recycling, Aurubis' Nordic range is exceptional with 97 % of copper produced for roofing and cladding applications over the last few years coming from recycled material. This material includes internal processing scrap (around 50-60 % of the recycled material). Embodied energy and global warming potential figures are therefore less than half those for copper generally – already significantly lower than stainless steel and aluminium.

Architectural Opportunities

Copper can provide a complete external skin, wrapping around complex building forms with material continuity. Alternatively, it can give distinctive character to individual facade or roofing elements, particularly when used in conjunction with other high quality materials. In addition, there is growing interest in the use of copper for interior design.



In addition to standard copper sheet, Aurubis explores new **Forms** of copper architecture with designers, including textured surfaces, profiled sheets and pressed surfaces. Also, perforated or expanded copper sheets and woven mesh add new possibilities for transparency. Installation techniques and **Systems** also help to define architectural character with texture and scale – ranging from traditional standing seam sheet installation techniques to panels, cassettes and other factory-made systems. Aurubis copper Forms and Systems are considered in more detail later.

But the natural colour changes leading to the development of copper's distinctive blue/green patina continues to fascinate architects and inform the development of Aurubis' **Nordic Surfaces**, discussed next.



Copper Surfaces

The natural development of copper patina is one of copper's unique characteristics.

Within a few days of exposure to the atmosphere, the surface of Nordic Standard copper begins to oxidise, changing its colour from the 'bright' mill finish to a chestnut brown which gradually darkens over several years to a chocolate brown. Continued weathering can then result in development of the distinctive green patina – or blue in coastal locations. This process is an expression of the metal's propensity to revert to mineral compounds that resemble the ore from which it originally came. The patina film provides impressive protection against corrosion and can repair itself if damaged, defining the exceptional longevity of copper cladding.

Some rainwater is needed for the patina to form and its rate of development will depend on the water 'dwell time' on a surface.

Extensive copper facades, patinating naturally and just becoming green after 40 years, on the iconic 'Dipoli' building in Otaniemi, Finland.

Architects: Reima and Raili Pietilä.

So, vertical cladding and sheltered surfaces will take much longer to patinate naturally than exposed roofs. Air borne pollution also increases the rate of patination, which therefore takes longer in more remote, cleaner environments than in cities or industrial areas. The complex combination of factors determines the nature and speed of development of patination, giving copper unique, living visual characteristics developing over time in response to local conditions.



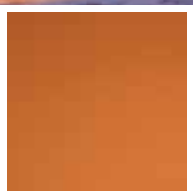
Nordic Surfaces

Over the last few decades, Aurubis has developed a range of factory applied surface treatments to provide straightaway the various stages of oxidation and patination. The processes involved are very similar to those taking place over time in the environment and utilise copper mineral compounds, not alien chemical treatments. Essentially, they bring forward the environmental changes without taking away the integrity of Aurubis copper as a natural, living material.

Aurubis' **Nordic Surfaces** include variable intensities of green or blue pre-patination and brown pre-oxidisation. Copper alloys brass and Nordic Royal™ – a golden alloy – are also available, adding to a rich palette of colours and surface textures. All Nordic Surfaces form an integral part of the copper and are not coatings or paint. Ongoing changes will continue over time with all Nordic Surfaces depending on the local environment, ranging from quite rapid with Nordic Brass to minimal for Nordic Royal™. Nordic Surfaces are supplied with a protective sheet to the finished face.

Aurubis' **Nordic Surfaces** are illustrated on the following pages. But Aurubis works closely with architects in developing bespoke surfaces and other techniques, in addition to the ranges shown here and our early involvement with the architectural design process is essential.





Nordic Standard

Nordic Standard – mill finish copper

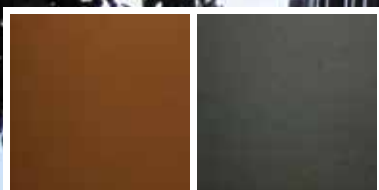
Nordic Standard is mill finish copper without any additional surface treatments carried out in the factory. It has the traditional 'bright' finish that will develop and change in the environment, as described earlier.

Nordic Standard is available in sheets or coils.

- ▶ Thickness range: 0.4 - 4.0 mm
- ▶ Maximum width: 1050 mm.







Nordic Brown™ Light Nordic Brown™

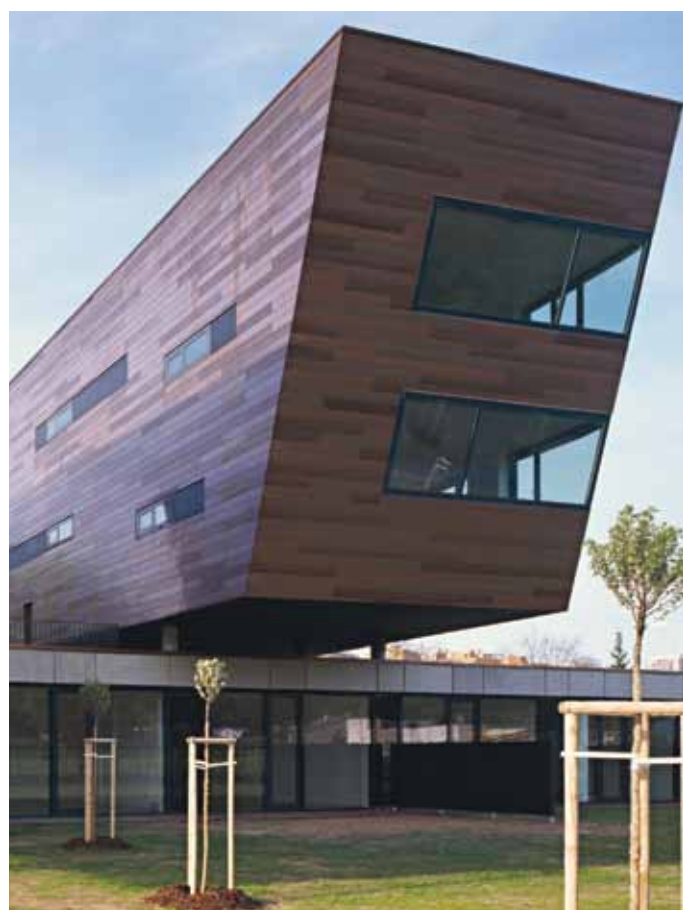
Nordic Brown – pre-oxidised copper

Nordic Brown™ products are pre-oxidised at Aurubis' factory to give straightaway the same oxidised brown surface that otherwise develops over time in the environment. The thickness of the oxide layer determines the colour: both Nordic Brown™ Light and the darker Nordic Brown™ versions are available.

Nordic Brown™ products are useful to minimise hand and other construction marks which can occur for a short time after installation with 'bright' standard copper. But light and dark versions can also be combined – perhaps with other finishes such as Nordic Standard – to create various visual effects.

Nordic Brown™ is available in sheets or coils.

- ▶ Thickness range: 0.5 - 1.5 mm
- ▶ Maximum width: 1000 mm.







Nordic Green™
Traditional

Nordic Green™
Living 1

Nordic Green™
Living 2

Nordic Green – pre-patinated copper

Nordic Green™ products offer designers unparalleled design freedom and the ability to determine the type and intensity of green patina for each project with choices of 'Living' surfaces. In a carefully controlled, factory process, pre-oxidised copper is treated with specifically formulated copper compounds to create the desired patina colours and heat-treated to chemically bind them to the copper.

The factory process can be accurately controlled so that, as well as the solid green patina colour, other intensities of patina flecks can be created revealing some of the dark oxidised background material. Aurubis' experts can also work in partnership with architects to develop special individual levels of patination to meet their design requirements or to match historically patinated copper on existing buildings.

The material is easily bent and formed, and there are no limitations on the length of pre-patinated copper sheet or strip because whole coils are treated on the production line, not just limited size sheets. Nordic Green™ is available in sheets or coils with one surface treated.

- ▶ Thickness range: 0.5 - 1.5 mm
- ▶ Maximum width: 1000 mm.





Mineral based green

The most common compound found in natural patinas all over the world is the copper sulphate mineral brochantite. Aurubis' factory-applied patinas have been developed with properties and colours based on the same brochantite mineralogy. Brochantite is a light blue colour but in many locations impurities and other components in the air add a yellow tint to give the naturally developed patina a green hue. In the same way, Nordic Green™ is produced with a hint of iron sulphate yellow component added to the blue copper sulphate, replicating the natural green.

By its nature, Aurubis' pre-patination process encourages the continuing formation of natural patina by releasing copper sulphate to react with the copper below. So, just like natural patina, Nordic Green™ undergoes continuous changes through environmental exposure dependant upon local atmospheric and rainfall condition.





Nordic Blue™
Living 1

Nordic Blue™
Living 2

Nordic Blue™
Traditional

Nordic Blue – pre-patinated copper

Nordic Blue™ products offer designers unparalleled design freedom and the ability to determine the type and intensity of blue patina for each project with choices of 'Living' surfaces. In a carefully controlled, factory process, pre-oxidised copper is treated with specifically formulated copper compounds to create the desired patina colours and heat-treated to chemically bind them to the copper.

The factory process can be accurately controlled so that, as well as the solid blue patina colour, other intensities of patina flecks can be created revealing some of the dark oxidised background material. Aurubis' experts can also work in partnership with architects to develop special individual levels of patination to meet their design requirements or to match historically patinated copper on existing buildings.

The material is easily bent and formed, and there are no limitations on the length of pre-patinated copper sheet or strip because whole coils are treated on the production line, not just limited size sheets. Nordic Blue™ is available in sheets or coils with one surface treated.

- ▶ Thickness range: 0.5 - 1.5 mm
- ▶ Maximum width: 1000 mm.



Mineral based blue

The most common compound found in natural patinas all over the world is the copper sulphate mineral brochantite. Aurubis' factory-applied patinas have been developed with properties and colours based on the same brochantite mineralogy.

In marine climates, the natural copper patina contains some copper chloride giving it more of a blue colour and this is emulated with Nordic Blue™. Brochantite is a light blue colour and Aurubis' Nordic Blue™ patination is 100 % brochantite.

By its nature, Aurubis' pre-patination process encourages the continuing formation of natural patina by releasing copper sulphate to react with the copper below. So, just like natural patina, Nordic Blue™ undergoes continuous changes through environmental exposure dependant upon local atmospheric and rainfall condition.





Nordic Royal™

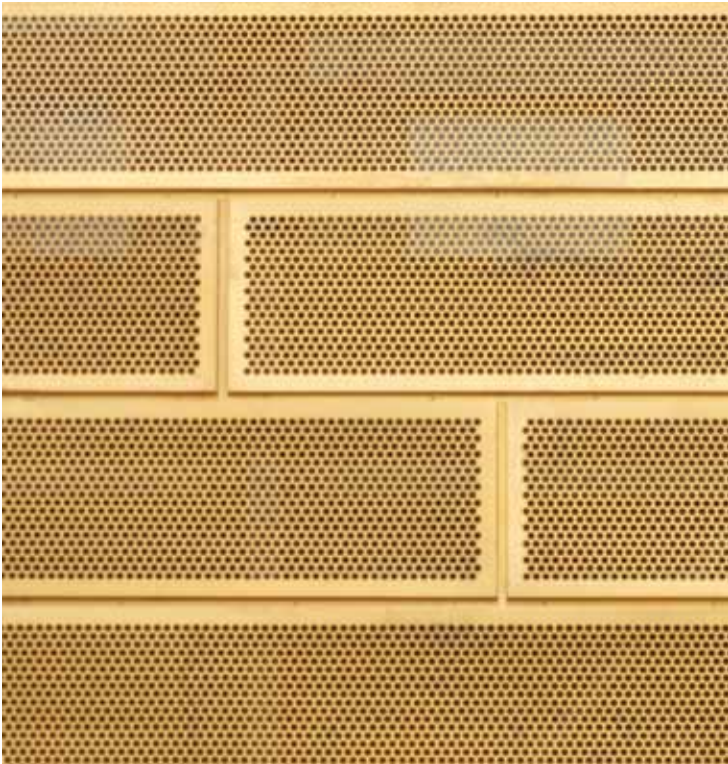
Nordic Royal – copper alloy

Nordic Royal™ is an alloy of copper with aluminium and zinc, giving it a rich golden through-colour and making it very stable. It has a thin protective oxide layer containing all three alloy elements when produced. As a result, the surface retains its golden colour and simply loses some of its sheen as the oxide layer thickens with exposure to the atmosphere to give a matt finish. It behaves differently to other Aurubis copper products over time and does not develop a blue or green patina.

Nordic Royal™ alloy is available in sheets or coils.

- ▶ Thickness range: 0.5 - 1.5 mm
- ▶ Maximum width: 740 mm.







Nordic Brass

Nordic Brass – copper alloy

Nordic Brass is an alloy of copper and zinc with a distinctive golden yellow colour. When exposed to the atmosphere, the surface begins to darken within weeks and can change to a dark brown in around a year – unlike Nordic Royal™ alloy which retains its original colour.

Nordic Brass is available in sheets or coils.

- ▶ Thickness range: 0.6 - 2 mm
- ▶ Maximum width: 1000 mm.





Nordic Forms

Apart from standard copper sheet, Aurubis is constantly exploring new forms of copper with designers, creating extra dimensions of modulation, texture and transparency for architectural surfaces. Nordic Forms include:

- › Nordic Decor™ textured surface
- › profiled sheets
- › pressed surfaces
- › perforated and expanded sheets
- › woven mesh

Most of these products are supplied by Aurubis and others are developed in a close working relationship with our specialist partners. In many cases, these products can be supplied with choices from Aurubis' Nordic Surfaces as well.



Nordic Decor Textured Surface

Nordic Decor™ provides a rustic, grainy surface texture embossed onto one face of copper sheets or coils. As well as providing visual interest close-up, it disguises hand marks and other blemishes, particularly when used internally (where oxidisation and patination may not occur).

Nordic Decor™ is available in sheets or coils.

- ▶ Thickness range: 0.6 – 1.0 mm
- ▶ Maximum width: 1000 mm.

Nordic Decor™ is available in the full range of Nordic Surfaces.



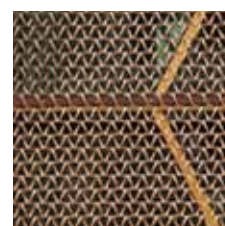
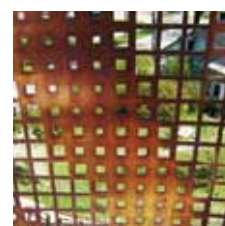
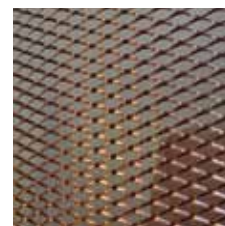
Profiled Sheets

Aurubis offers an extensive choice of roll-formed or welded profiled sheets in the full range of Nordic Surfaces: full technical details are available on the website. Other, bespoke profiles can also be provided to order.



Perforated, Expanded and Woven Mesh

Aurubis offers a range of standard perforation patterns onto its copper sheet with any Nordic Surface, as well as special, bespoke patterns. Variable perforation sizes can be used to create subtle patterns, 'super graphics' and even text. Our partners can also provide expanded copper sheet with any Nordic Surface or woven copper wire mesh to suit particular requirements.



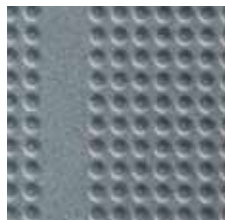
Transparency with copper

Perforated and expanded copper sheet, and woven copper wire mesh add an extra dimension of transparency. For example, the Sven Harry Karlsson Museum (shown here and on page 25) uses perforated Nordic Royal™ for ceilings, soffits and cladding, as well as mesh to divide balcony areas.



Pressed Surfaces

Our partners can press mould Aurubis copper sheet which has any Nordic Surface – including perforated and expanded forms – using advanced techniques to suit bespoke designs.





Large areas of Long Strip roofing, created with Nordic Green™ pre-patinated copper, are used throughout the Tsaritsyno Palace in Moscow.

Nordic Systems

We have seen how an unrivalled choice of Nordic Surfaces can be combined with different Nordic Forms to provide a rich copper palette for contemporary architecture. The final ingredient in designing with copper is the installation technique or system, which will add 'grain' and structure to the external skin of the building helping to define its character. Aurubis provides an extensive range of factory pre-fabricated Systems for facades or roofs, as well as copper sheets or coils and other copper items.

prefabrication and jointing on site. Aurubis copper can be supplied in cut-to-size sheets or in coils to suit any system.

In particular, Aurubis is unique in its ability to supply any of its Nordic Surfaces in coils for Long Strip.

Traditional Techniques

Traditionally, copper has been used as a lightweight, fully supported covering to roofs, walls and other building elements. Here, sheets of copper are jointed using double lock standing seams (or angle seams for vertical cladding) visually defining the copper bays, interrupted by cross-welt joints running longitudinally.

A more modern interpretation of fully-supported, standing seam technology is Long Strip. In this case, copper trays are prefabricated with profiles and installed in long lengths – perhaps 10m or more – eliminating cross-welts and creating a strong linear appearance. Long Strip is an efficient and cost-effective method where mechanisation can be maximised both for



Prefabricated Systems

Apart from traditional systems, various standard or bespoke prefabricated systems are available in Aurubis copper. They offer the benefits of consistency and accuracy, being fabricated under controlled off-site conditions, as well as different visual characteristics helping to define the architecture.



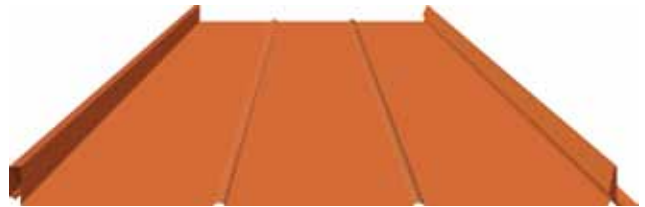
Aurubis fabricates four ranges, each with various systems, providing a wide choice of visual scale and detail. Just a few examples are shown here and full technical information is available in the Designers Tools sections of each range on the website www.aurubis.com.

Prefabricated trays

The RPRE 105 prefabricated tray is a fully-supported 0.5 - 0.6 mm thick copper tray, pre-formed ready for fast, efficient installation.

Width: 475 mm

Maximum length: 8 m



Shingles

Fully supported copper elements for facades or roofs, shingles offer a distinctive 'fish scale' appearance with shapes including squares, diamonds, rhomboids and rectangles (as shown opposite), in various sizes. The RMOD 402 shown below is 280 x 280 mm using 0.6 mm copper.





Panels

For facades, self-supporting copper panels pre-formed on two sides can be used vertically, horizontally or diagonally to give a linear, striated appearance. Various shapes and sizes are available. The example shown here is FPAN 101 using 1.0 - 1.2mm thick copper –
Height: 200 - 300 mm
Maximum length: 3 m



Cassettes

For larger flat areas, cassettes have squarer proportions with folded edges to all four sides. Various types and sizes are available. The example shown below is FCAS 101 using 1.0 - 1.5 mm thick copper –
Height: 450 - 900 mm
Length: 450mm - 3 m



Other Architectural Elements

Today's designers continue to explore new areas where copper's unique characteristics can influence architectural expression. Aurubis responds by working closely with our specialist partners on new systems and products to meet designer's specific needs. For example, slatted and louvred facade systems add another architectural dimension, providing solar shading and privacy while retaining transparency.



Interior Elements

Aurubis' growing palette of surfaces, forms and systems inspires designers to use copper inside, as well as on the exterior surfaces of buildings. Applications include partitions and walls, ceilings and soffits – perhaps extending to the outside with complete material continuity. Door facings, push-plates and other 'touch surfaces' also benefit from copper's antimicrobial properties.



Working with Aurubis

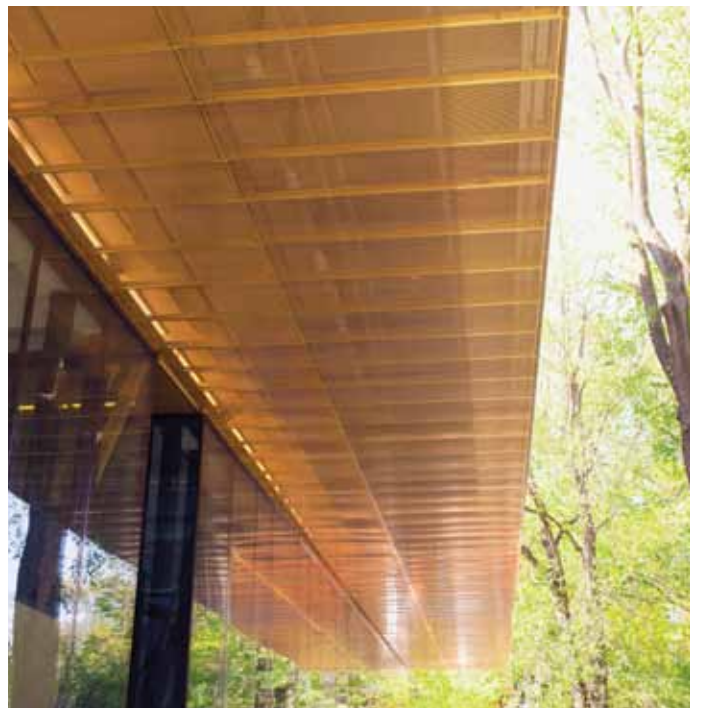
We hope that this brochure has given you an insight into Aurubis' copper architecture and inspired you to consider how it can contribute to your designs. To complete this journey, a few project case studies demonstrate the importance of our expertise and personal service to developing designers' architectural visions in copper.

The Sven Harry Karlsson Museum, Stockholm

This multi-purpose building in the heart of the city, designed by Wingårdh Architects, demonstrates different forms and systems all using a single surface: Nordic Royal™ alloy. As well as enabling the public to enjoy Karlsson's unique collection of mainly Swedish art, the building contains a fully glazed restaurant, apartments and a penthouse with sculpture park and roof-garden. The penthouse replicates the form of Karlsson's beloved home in Ekolmsnäs but is wrapped with perforated cassettes in front of alloy-clad facades and roofs – all in Nordic Royal™ providing material continuity. Lighting in the void between creates dramatic effects through the perforated golden metal at night.

Architect Gert Wingårdh explained the design concept: *"The Museum relates to its surroundings and context like a piece of precious metal jewellery with a sparkling diamond on the top. Rigorous on the outside but with an interior full of surprises. Art, food, living and culture all meet everyday life on the street. Aurubis played a key role in helping us to develop the different elements in the alloy which are central to our design concept".*

Aurubis was involved with all aspects of the design, detailing and installation of the copper alloy elements from the start. The main facades are clad with storey-height cassettes of varying widths, and perforated panels with lighting above are used extensively for ceilings both inside and out. Some internal walls and doors are also clad in Nordic Royal™.



The Helsinki Music Centre

Located in a pivotal city location facing the Parliament House, the Helsinki Music Centre, complete in 2011, exemplifies a considered approach to combining copper surfaces, forms and systems. LPR Architects' competition-winning design included a solid green mass, reflecting and terminating the nearby public park, always envisaged in pre-patinated copper cladding. During the detailed design phase the architects worked closely with Aurubis in developing softer facade treatments, reflecting the project's 'Mezzo Voce' (silent voice) theme and contextual approach.

Architect Marko Kivistö explained: *"We developed an exceptional working relationship with Aurubis, following cooperation on a previous project. Aurubis experimented with and tested a pierced leaf motif, then we moved on to more abstract patterns of cut-out rectangles. Finally, we settled on vertical patterns defined by press-moulded circular dimples and pierced circles which are less aggressive but still give texture and life to the surfaces seen at different distances. Copper has a human touch! Different patination levels were also trialled and we settled on Aurubis' Nordic Green Living 1, although solid green was used for perforated panels over ventilation plant to mitigate the dark holes".*



Marko Kivistö is also experimenting on other surface treatments with Aurubis technical experts to apply photographic images, including silk-screen printing of patina. He said: *"One small project uses images of nature – water, stone reeds – as an integral part of Nordic Green and Blue material. Then inside, other natural forms such as lichen were cut into Nordic Brown sheet. Being able to work closely with experts like Aurubis, keen to investigate new possibilities, is essential for designers".*





Warsaw Jewish Museum

The Museum of the History of Polish Jews, under construction in Warsaw during 2011, features a layered facade design using pre-patinated copper in combination with glazing. The competition-winning design, by Architects Lahdelma & Mahlamäki (working in conjunction with Kurylowic & Associates in Poland) features a regular grid of vertical, alternating glass and copper panels, saw-tooth across the building face.

The Nordic Green™ Living 1 copper surface is pierced with square holes for ventilation: earlier trials experimented with expanded copper sheet. This contrasts with the glass which is decorated with white Hebrew and Latin text motifs. Behind, and separated by a void, the facade plane is clad with matching green copper in vertically corrugated sheet form, incorporating some windows.

Professor Rainer Mahlamäki added: *“The final facade build-up is the result of on-site trials with full-scale mock-ups. It aims to create the luminous green, vertically folded surface envisioned in the competition-winning design. Aurubis helped us from the early design stages and we visited their factory to select the surfaces and forms of copper needed to realise our original vision for the facades”.*

The sharp, engineered rhythm of the copper and glass saw-toothed facades contrasts with an organic, free-form route through the building, representing the parting of the Red Sea and deliverance. The architects' intent is to create a lantern in the park and the play of advanced LED lighting behind the decorated glass on the green corrugated copper will play a key role in this.





Our copper for your life

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