Polychrome: the many colours of stainless steel

Stainless steel is famous for its chrome colour, which has given it a reputation for “greyness”. But this image is undeserved: first, there are several ways that the surface of stainless steel can be modified to absorb or reflect light in different ways, or obtain different textures or gradations of soft and hard. Secondly, there is colour. One of the more exciting results of surface-finishing of stainless steel is that certain colours can be obtained. Therefore, besides the practical benefits of stainless steel (low maintenance, corrosion resistance etc.), colour adds new possibilities of exploring its aesthetic aspects. The potential is enormous, especially in architecture, art and interior design.

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Introduction

In many application of stainless steel, surface treatment and finish and are all-important in determining not only certain of its functional properties (corrosion resistance, hardness and hygiene) but also its appearance and aesthetic quality. Although almost all stainless steels can be surface-treated to produce colours, some types are open to a wider range of colours than others. Austenitics, especially 304 and 316, can be made to resemble most of the colours of the rainbow. Options for ferritic and duplex are more limited: for instance, the only colour available for ferritic grades is the dark grey obtainable through electrochemical treatment.

Titanium colour

Titanium can be coloured using exactly the same method as with stainless steel. Electrochemical colouring can be used in sporting equipment, colour-coded nuclear containers or surgical tools, spectacle frames or jewellery. Among architects, Frank Gehry has done the most to exploit the potential of coloured titanium, in such buildings as the Hotel Marqués de Riscal in the Rioja region of Spain, the Art Gallery of Ontario in Toronto, Canada, and the Experience Music Project in Seattle (see photo above).

Coating

It is always possible to paint stainless steel, as is often done with carbon steel. But whereas carbon steel is painted for corrosion resistance (among other reasons), the reasons for painting over stainless steel are different: for instance, a stainless steel surface can be partially painted to enhance visibility on lorries, handrails and other objects where safety and convenience are important. Stainless steel can also be coated in a coloured metal such as tin, in external wall panels or roofing. A special type of painting is coil coating, the inline colouring of stainless steel coils. Coil coating consists of a prime and finish coating. It is used for applications where corrosion resistance is
COLOURED STEEL

called for without a reflective surface, for instance in tunnel lining. It is also used in furniture, domestic applications, cold-storage rooms and metallic doors.

Electrochemical process
The most popular method of colouring stainless steel is the electrochemical process, also called electrocolouring. Known also as the INCO system, it was first developed by International Nickel (INCO) in 1972. Various processes are used, usually involving immersion of the stainless steel in a hot solution of chromic and sulphuric acids or in a hot alkaline solution. Afterwards the stainless steel is rinsed and surface-hardened by cathodic treatment. The colour that results depends on controlling the thickness of the oxide layer, which in turn depends on immersion time. The thickness in the oxide layer ranges from 0.02 microns (to colour bronze) to 0.36 microns (to produce green). This “colouring” process uses a trick of nature known as light wave interference (box), and the angle at which the surface is viewed will change the colour perceived by the viewer. For the same reason, curving will have the same effect. The spectrum of available colours ranges from bronze to blue, black, charcoal, gold, purple and green. The colours can be combined with various satining finishes (such as mirror, scotch brite, hairline or cross-satinizing) to obtain various patterns.

Electrocolouring is normally applied to sheet. Advantages are that no dyes or pigments are used, and that the colours are ultra-fast and impermeable to UV rays (in other words, they do not degrade in sunlight). A disadvantage is that scratching and corrosion (which changes the colour) cannot be repaired.

PVD
In Physical Vapour Deposition or PVD, a thin ceramic layer is applied to the surface of the stainless steel to produce colour and enhance durability. A variety of vacuum deposition methods are used to deposit the film. The coating material is placed in vacuum, where it is heated to a high temperature. After achieving vaporized form it recondenses and is then deposited onto the desired surface. The technique was first used by Michael Faraday in 1838, though the term was not used until 1966. Various forms of PVD have evolved. A new treatment offered by the Italian company Steel Color Spa involves the deposit of titanium compounds.

Important markets for PVD technology include architecture (hotels, railway stations, retail; stores) and interior design (door handles, furniture, display cases). But it is also used in several industrial applications, for instance to replace chrome plating in auto production, in

Light wave interference
Interference occurs when two waves superimpose to form a resultant wave of greater or lower amplitude. Examples include the rainbow effect visible in soap film, on a bubble, on the mirrored surface of a CD or on oil floating on water. When white light hits the polished surface of stainless steel, some of the light bounces off the surface, whereas the rest passes through the oxide layer (which is colourless) and bounces off the base metal. The two waves interact (interference) and produce a resultant wave the colour of which varies according to the depth of the oxide layer.

Nomade, by the Catalan sculptor Jaume Plensa, has been gazing out to sea ever since it was installed in 2010 on the ramparts of Antibes in the south of France. This hunched, hollow figure is entirely made up of letters in stainless steel, painted white. Children can clamber up the inside, and, most appropriately, editors can peer through the letters. Photo: Mark Chater.
semiconductor wafers, surgical tools, drill bits and guns. Advantages compared with electrocolouring include greater consistency and uniformity of colour and greater abrasion resistance. Unlike with the electrochemical process, the surface colour will not change with the angle of view.

Blackening
Stainless steel can be blackened by immersing it in a molten salt bath of sodium dichromate. This method is used in the auto industry and in stainless steel solar collector panels, which absorb light in order to heat water. Black stainless steel mesh was used on the Ecole Polytechnique Fédérale de Lausanne, Switzerland, as solar protection. It was coated with a permanently bright UV varnish, a weather-resistant varnish and a semi-gloss special varnish.

Architecture and design
The main application for coloured stainless steel is architecture, including façades, roofing, columns, signs and display panels. A closely related application is in-door design, including furniture.

Several striking architectural statements have been made in recent years, thanks to coloured stainless steel. In the UK Rimex Metals supplied a shimmering steel facade for a hotel in London’s docklands, with tiles ranging from green to purple. The same company supplied a bronze mirror finish to the Leeds University Archive building. The Beacon Center at Blackburn College has a softer, more discreet finish in grey blue. The Tower of Love Pavilion in Blackpool received a highly appropriate gold mirror finish. Millennium Tiles applied electrochemically coloured and natural stainless steel shingles on the exterior walls of Southwest Oregon Regional Airport in the United States. A private house in the Bahamas was covered in bronze and slate-colour tiles to achieve a striking contrast.

Asia’s continuing building boom is proving a ready market for coloured stainless steel. For example, Double Stone Steel is...
supplying PVD coating from as many as ten factories in China to several locations in Asia. It supplies not only hotels, casinos, shopping malls, railway stations and retail stores, but also display cases, furniture, lighting, door handles and taps.

Sculpture
Among the sculptors who have used coloured stainless steel are Gary Caldwell, Olafur Eliasson, Jeff Koons, Diane Maclean, Teo San José and Leon Zhao. Few artists have explored the material more thoroughly than Jeff Koons. A master of illusion, this New York-based artist has been described as an artist who “makes granite look like plastic, plaster look like metal, and metal look like a stretched balloon” (www.gpidesign.com). Where most sculptors tend to affirm the nature of the materials they use, in his stainless steel sculptures Koons does the reverse: a solid, dense material is made to appear inflatable and light. Many of his sculptures recall balloons or inflatable toys, or combine the formal elements of balloons and animals. Thus three of his works are titled Balloon Swan, Balloon Rabbit and Balloon Monkey; they are coloured blue, yellow and red respectively. His recent work Tulips represents a bouquet of twisted balloon-shaped, vividly coloured flowers cast in stainless steel with a high mirror polish. Though giving the impression of weightlessness, the sculpture in fact weighs three tons.

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