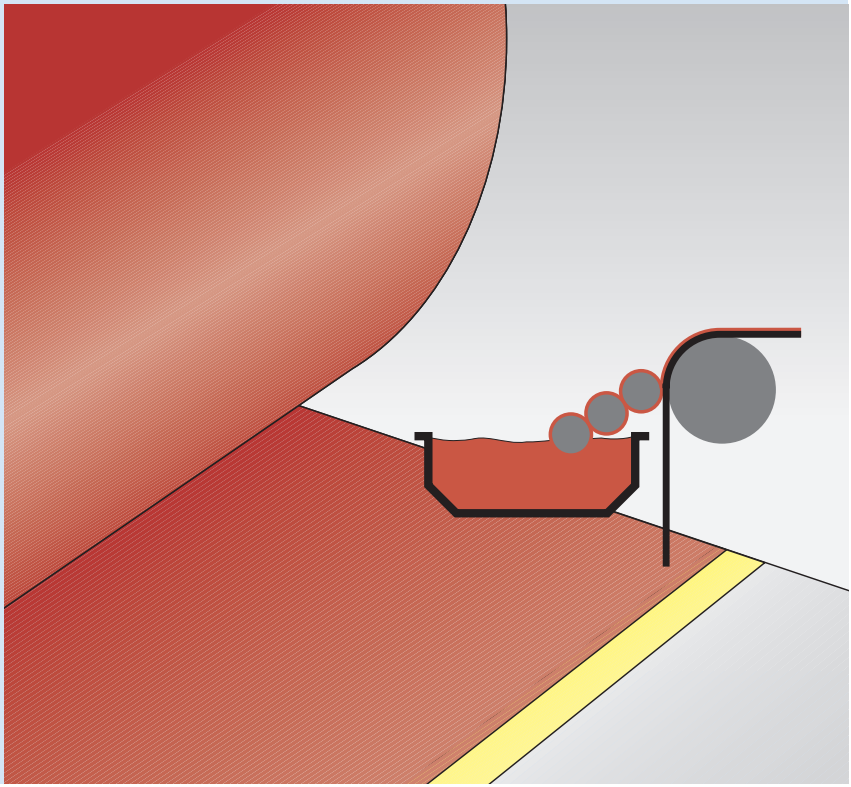
Characteristic Properties 093 – E

Continuously Organic Coated Steel Flat Products



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1 Introduction

The coil coated flat product is a composite material made of a metallic substrate and an organic coating that combines the excellent properties of both components. The special properties are corrosion resistance, formability, and decorative appearance.

This document is intended to inform consumers and finishers of coil coated flat products (strip and sheet) made of steel about current availability and applications.

It is a summary of the characteristic properties of coil coated flat products and is intended to help to avoid misunderstandings between steel producers, consumers and processors when ordering, delivering, processing and utilising.

The document deals with coil coated flat products that are created from coating cold rolled, electrolytically zinc coated or hot-dip coated strip. Other coated steel materials are available by special order, too.

The contents of German industrial standard DIN EN 10169 entitled "Continuously organic coated (coil coated) steel flat products – Technical delivery conditions" ("Kontinuierlich organisch beschichtete (bandbeschichtete) Flacherzeugnisse aus Stahl – Technische Lieferbedingungen") are taken into account in these technical guidelines, as are those of German industrial standard DIN EN 13523 entitled "Coil coated metals – Test methods", Parts 0-29 ("Bandbeschichtete Metalle – Prüfverfahren", Teile 0-29).

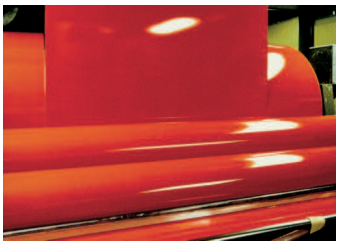
Coil coated flat products have a long-established place among applications in the industrial sectors of construction, domestic appliances and general sheet metal processing. Additionally, they are employed in vehicle manufacturing.

There are often important considerations in selecting the suitable composite material that derive from the type of processing and finishing that is planned. Thus, it is in the interests of consumers and finishers to indicate the intended purpose to the manufacturer of coil coated flat product.

2 Environmental aspects

The coil coating process combines in large measure environmental compatibility with economy. Coil coating lines incorporate integrated equipment for wastewater processing as well as exhaust emission scrubbing and exceed the statutory regulations for emissions. By employing modern energy recovery processes, primary energy consumption is significantly reduced and CO_2 emissions as well. The consumption of coating material can be optimised as well as wastage minimised by the efficient application techniques in the coil coating process. This process is therefore environmentally friendly and conserves resources more than piecewise coating.

Furthermore, the steel industry has been actively working for years on reducing and/or avoiding the use of materials containing heavy metals. The basic zinc coated substrates employed for coil coating products are therefore lead-free and cadmium-free already today for example. The same holds true for the pretreatment compounds in the coil coating process. Chemical systems devoid of chromium (VI) are employed today for nearly all applications and these fulfil customer requirements with respect to use and finishing. Pre-treatment with very low chromium (VI) content can be utilised for special applications just as



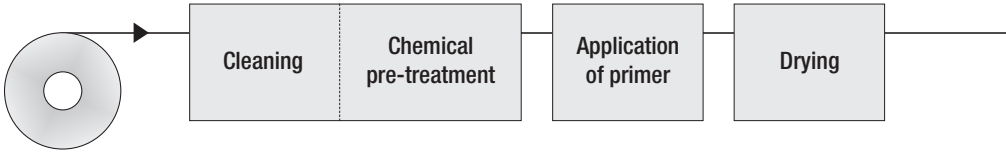


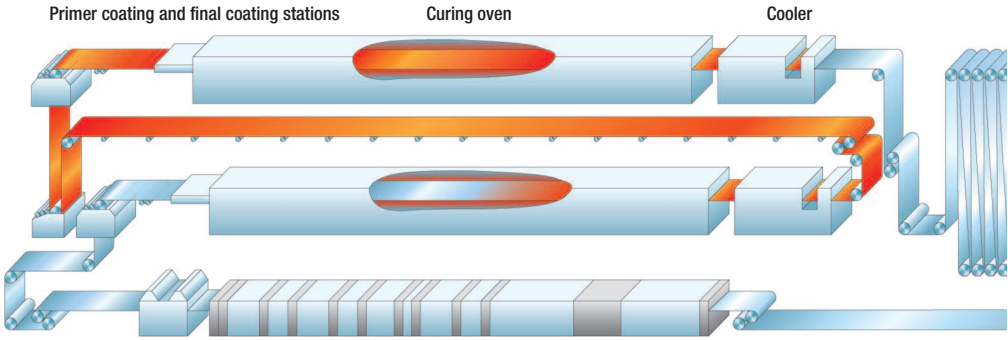
Fig. 1: Significant steps in the process of coil coating

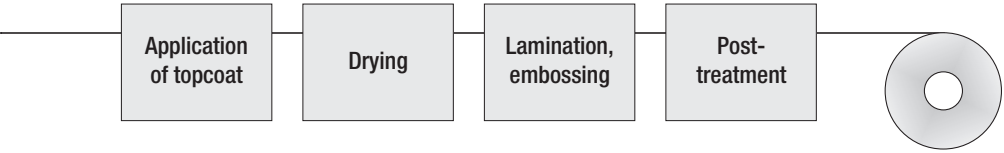
before. Special attention is paid to the health and environmental compatibilities of paints, varnishes, and coatings also. The REACH regulations and guidelines of the European Parliament and of the Council for avoidance of critical ingredients such as PCBs, flame-retardants containing polybromides or materials containing chromium (VI) (Directives 2002/95/EC and 2003/53/EC) are adhered to through these actions by suppliers. Alternative compounds are substituted for critical ingredients in accordance with the guidelines in a timely manner.

3 Manufacturing processes

Cold rolled, electrolytically zinc coated or hot-dip strip is cleaned, chemically treated in preparation for coating, and coated one-side or two-sides in a continuous process. Coating can be car-

Fig. 2: Diagram of a coating line

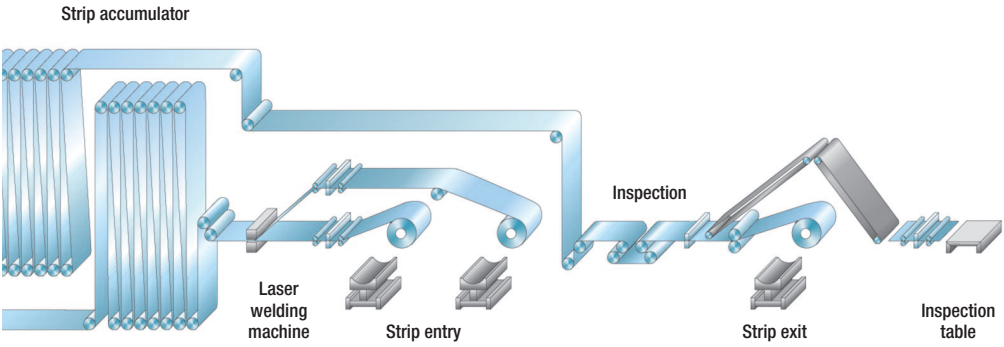




ried out by applying liquid paints and varnishes that are hardened in the process. The substrate material can be optionally coated by laminating with a layer of plastic film. A multiple layer coating type is also possible, depending on the combination of requirements.

Reproducible and consistent product quality is ensured by an established quality management system that includes continuous production processes on the flat substrate, continuous process monitoring with in-line measurement equipment and quality inspections of the coated flat products. All of the processes are subject to continuous improvement. All the suppliers are certified in accordance with DIN EN ISO 9000 ff. and DIN EN ISO 14001 and are regularly audited by authorised institutions.

The use of coil coated flat products permits finishers to significantly reduce their finishing depths and their associated expenditures.



4 Delivery options

Available dimensions included in the delivery program of the steel producer should be chosen for individual orders. In general, the order thickness for coil coated flat products does not include the thickness of the organic coating.

4.1 Delivery forms and dimensions

4.1.1 Organic coated strip in rolls (coils)

Widths: from 600 to 1870 mm
Thicknesses: from 0,30 to 3,00 mm
Standard coil ID: 508 mm; 610 mm

Suppliers deliver coils of different maximum and minimum weights, depending on width, length, and thickness of the strip.

4.1.2 Organic coated strip in sheets

Widths: from 600 to 1870 mm
Thicknesses: from 0,30 to 3,00 mm
Lengths: up to 7500 mm

4.1.3 Slit strip of organic coated strip

Widths: from 20 to 600 mm
Standard strip ID: 400 mm, 508 mm, 610 mm

4.1.4 Bars of organic coated strip

Check with the suppliers for the available lengths.

4.2 Delivery quantities

The minimum quantities available must be arranged with the steel producer.

5 Grades

5.1 General

Products in different versions can be delivered, depending on intended end-use. It is therefore in the interests of customers to arrange the necessary version for the particular application with the steel producer. In addition to the properties of the organic coating, attention should be paid to the correct choice of the substrate.

- DIN EN 10169:2011
  Continuously organic coated (coil coated) steel flat products – Technical delivery conditions

5.2 Substrates

The mechanical and technological properties of the substrates, as well as the corresponding metallic coatings are described in the subsequent technical regulations (see Chapter 14).

Note: The mechanical and technological properties of the substrates indicated in the regulations can change due to coil coating. The steel producers have gained appropriate experience. Freedom from coil breaks and stretcher strains must be specially agreed to.

5.2.1 Cold rolled flat products

- DIN EN 10130:2007
  Cold rolled low carbon steel flat products for cold forming – Technical delivery conditions
- DIN EN 10268:2006
  Cold rolled steel flat products with high yield strength for cold forming – Technical delivery conditions

5.2.2 Metallic-coated flat products

- DIN EN 10152:2009
  Electrolytically zinc coated cold rolled steel flat products for cold forming – Technical delivery conditions
- DIN EN 10346:2009
  Continuously hot-dip coated steel flat products – Technical delivery conditions
- SEW 022:2010
  Continuously hot-dip coated steel flat products – zinc-magnesium coatings – Technical delivery conditions

In principle, all flat products can be employed as substrates in organic coil coated lines. The coatings listed in **Table 1** have established themselves in customary applications. The broadest spectrum of coatings is employed in the construction industry.

With the exception of electrolytic zinc coatings, the coatings identified are created in a hot-dip coating process. This process is often called as hot-dip zinc galvanising, too.

Zinc-magnesium coating

Sheet steels with a coating of zinc-magnesium alloy are the newest development; they have been available since 2007. This coating is created like conventional metal coatings by submersion in an appropriate molten bath that contains 92% proportion of zinc at a minimum as well as proportions of aluminium and magnesium of summarized up to 8%. The zinc-magnesium coating is described in the Stahl-Eisen-Werkstoffblatt (SEW) 022.

Zinc-magnesium alloy coatings offer considerably improved corrosion resistance in comparison to conventional metallic coatings. This material can be coil coated with all of the usual organic coating systems.

The [metallic] coating thicknesses for organic coated ZM steel sheet can be sharply reduced compared to traditional coatings thanks to the high specific corrosion resistance. ZM substrate materials for organic coated structural components are employed with a layer of 60 to 140 g/m² as a rule. The use of zinc in this instance conserves resources, since usually a layer of 275 g/m² is used.

Coating	Short name	Introduction in Europa
Zinc	Z	1959
Electrolytic zinc coated	ZE	1970
Zinc-Aluminium	ZA	1984
Aluminium-Zinc	AZ	1986
Zinc-Magnesium	ZM	2007

Table 1: Typical metallic coatings for organic coil coated flat products

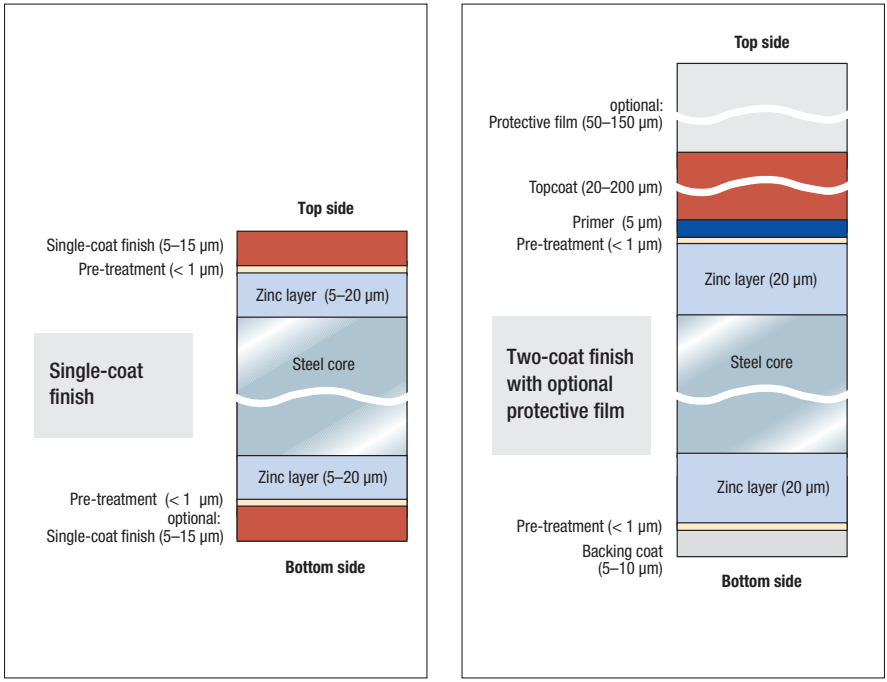


Fig. 3: Schematic representation of typical setup for organic coated flat products

Organic coated ZM flat products' properties for further processing resemble those of the version Z. Organic coil coated flat products with zinc-magnesium coating have German and European construction supervision approvals.

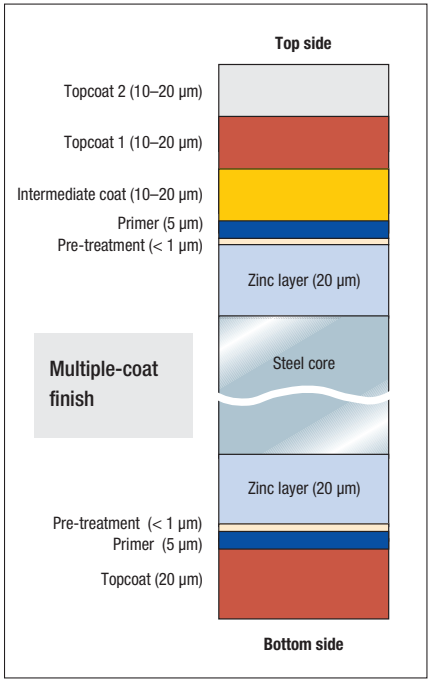
5.3 Coating

5.3.1 Paints and varnishes

The paints and varnishes most commonly considered for coil coated flat products are summarised in **Table 2** (page 12–13) with their usual film thicknesses (dry film thickness), short names and outline of their properties.

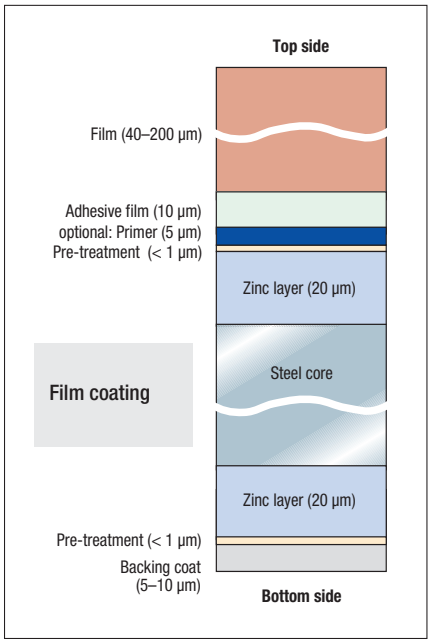
5.3.2 Coating setup

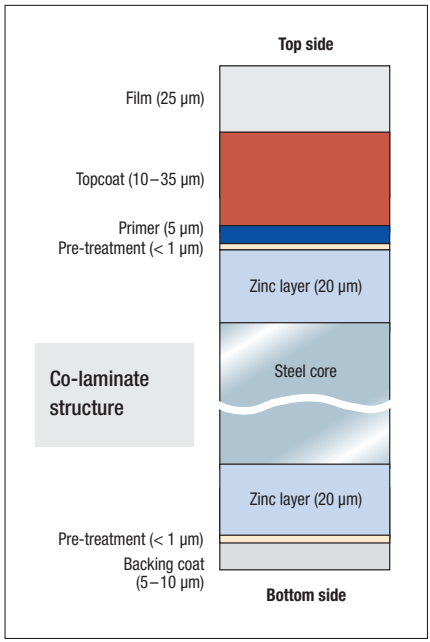
The diagrams (**Fig. 3**) illustrate the typical kinds of organic coated flat products that are available or can be ordered. The choice of coating setup – specified by the kind and thickness of the coatings – is arranged between the customer and the steel producer.



For the coating types of the schematic representations following definitions apply to in details:

- Backing coat:
  Single-layer finish with choice of coating material, no requirements for appearance, formability, corrosion resistance, etc. (see also clause 6.3).
- Single-coat finish:
  Single-layer finish with limited requirements for appearance, formability, corrosion resistance, etc. Single-coat finishes distinguish themselves from backing coats as a rule by a higher coating thickness.
- Two-layer finish:
  Two-layer finish consisting of a primer and a topcoat with requirements for appearance, formability, corrosion resistance, etc. Some paints and varnishes are only available as a two-coat system. Two-layer finishes can also be applied two-sides and optionally one-side with





a strippable protective film. Some two-layer finishes are also available in an embossed or textured form.

- Multiple-coat finish:
  Comprises primer, intermediate coat(s), and topcoat with special requirements for appearance, formability, corrosion resistance, etc. Multiple-coat finishes can also be applied to both sides. As only two paint coats can be applied during a single run through the line as a rule, a second run is necessary for multiple-coat finishes that causes higher costs in addition to the coating materials used. Various multiple-coat finishes are also available in embossed or textured form.
- Film coating:
  Application of a decorative film that adheres permanently to the substrate. A heat-activated adhesive film about 10 µm thick, if needed also a primer, is generally applied to the substrate beforehand. If a film is applied to a two-coat finish, it is referred to as a co-laminate. Film coatings are only available one-side. They are available as single colour or printed, as well as optionally embossed.
- Protective film:
  Strippable plastic film, see also clause 5.3.3.

With embossed coatings, the coating thickness is specified including the embossing; with textured coatings, a mean coating thickness is quoted.

Composite strip and sheet designed for damping are a special feature in the material structure. This involves a sandwich construction from two (continuously organic coated) external steel sheets with a viscous elastic intermediate layer. More detailed information is listed in the document "Charakteristische Merkmale 090" from the Stahl-Informations-Zentrum.

The top side is generally considered by the steel producer to be the side of the strip lying face up and continually monitored during the fabrication process. This is the side of the strip that must meet the most stringent requirements for appearance and/or corrosion protection.

The bottom side of the strip normally receives a backing coat (protective finish). Other systems are possible in case of special requirements for corrosion protection and decorative appearance.

The top side customarily faces outwards when delivered in coils, face-up when delivered as sheets or bars. If the customer wishes to have the top side facing differently, this should be explicitly indicated at the time of order.

5.3.3 Surface protection

If special exposures are expected during transport, storage, finishing or assembly, coil coated flat product can be delivered by the steel producer additionally with a one-side strippable protective film by arrangement.

The kind, thickness, adhesion properties, formability, tear resistance, and light stability must be considered when selecting the protective film. If the protective film is removed only after the structural component has been installed, this must occur within one month after installation. Only special protective films can be exposed to external weathering – and then only for a limited duration.

There are two different kinds of protective films:

- strippable films with adhesive film, thickness 50–120 µm
- strippable heat-laminated films without adhesive film, thickness 80–150 µm

They are transparent as a rule, but can also be pigmented. Protective film types without adhesive film (known as heat-laminated films) are far more commonly used.

6 Properties and areas of application

6.1 Properties

6.1.1 Functional properties

Organic coil coated flat product already has a finished surface. This replaces the coating applied by the customer. Consequently, this material exhibits physical properties for shaping work by the customer and also inherent properties for later use of the final product. These properties additionally improve the environmental balance by eliminating local emissions and disposal by the processor.

The most important functions for organic coil coated flat products are summarised in **Table 2.** These properties should only be looked at in relation to one another; measurements are dependent upon the substrate and are therefore not listed in the Table.

The following essential physical properties should be considered in processing and use.

Processing:
Adhesion of the coating and the protective film as appropriate, taking into account the cutting, shaping, joining, and assembly steps; formability; hardness; abrasion resistance; and sliding properties.

Behaviour in use:
Resistance to influence of weather; corrosion resistance, if necessary including specific aggressive substances that may occur in practice; resistance to specific contact materials; resistance to heat; hardness; abrasion resistance.

- Robustness:
  Ability to withstand mechanical stress, wear resistance, scratch resistance, abrasion resistance
- Resistance to heat:
  This is understood to be other than continuous exposure.
- UV resistance:
  Resistance to sunlight; this comprises alteration of colour and specular gloss as well as chalking behaviour.
- Corrosion resistance:
  This is understood to be the behaviour of the composite material in relation to aggressive media in the natural atmosphere. With the exception of EP coatings and co-laminates, the coatings fulfil the requirements of corrosion protection category III in accordance with DIN 55928 Part 8 in so far as the thickness of the hot-dip coating corresponds at a minimum to the Z275, ZM120, ZA255, or AZ150 finishes (see also the relevant standards in clause 5.2.2).

  With introduction of ZM hot-dip coating, corrosion resistance of the structural components on flat surfaces and areas of bending can be significantly improved. ZM-coated sheet distinguishes itself by almost no tendency to form red rust and a reduced subsurface migration of the paint or varnish from cut edges. These positive properties are based upon cathodic protection and additionally on the formation of thin, very dense oxide layers containing magnesium, so that the progression of corrosion is considerably slowed.

Properties	Coating[1]			
	EP	SP	PUR	PUR-PA
	Epoxy	Polyester	Polyurethane	Polyamide-modified PUR
Coating thickness[2] [µm] not including adhesive film for film coatings	10 (3–20)	25 (5–60)	25 (10–60)	25 (10–50)
Specular gloss	10–50	10–80	10–80	10–40
Max. heat resistance °C	80	80	80	80
Surface hardness				
Formability/bending (T-bend)				
Formability/roll forming				
Formability/deep drawing				
Abrasion resistance				
Resistance to weathering, UV resistance				
Resistance to weathering, corrosion resistance				

[1] The abbreviations have been selected in conformance with DIN EN 10169 or its meaning.

[2] The initial value gives the usual coating thickness.
The range of coat thickness that is technically feasible is shown in parentheses.
Additional temporary protective films are not included.

The other properties are based on the respective usual coating thickness of the coating.

Table 2: Properties of coil coated sheet

Coating[1)]					
HDP	**HDP-PA**	**PVDF**	**PVC(P)**	**PVC(F)**	**SP-PET(F)**
High-Durability Polyester	**Polyamide-modified HDP**	**Polyvinylidene fluoride**	**Polyvinyl chloride plastisol**	**Polyvinyl chloride**	**Co-laminate**
25 (25–60)	25 (15–50)	35 (20–60)	100–200 (40–200)	100–200 (50–800)	35–65 (35–65)
20–80	10–40	20–40	45–70	5–15	20–80
80	80	110	60	60	80

Excellent
Very good
Good
Satisfactory
Sufficient
Unusable or inappropriate

– Reaction to fire
Since publication of the 2002/1 construction regulatory list, new construction materials are classified according to DIN EN 13501-1. Non-combustible construction materials with no combustible components are labelled A1, construction materials are classified by increasing inflammability up to level F, easily inflammable. Further, the standard differentiates according to the addiction of the construction materials to produce smoke (s = smoke) and by propensity to produce flaming droplets/particles (d = droplets), as shown in **Table 3.**

Coil coated flat products with an organic coating thickness of 25 µm are classified as A1 – non-combustible. Depending on execution, components manufactured with mineral wool can attain group A2-s1, d0. This execution of the construction component contributes insignificantly to fire load and fire growth. Foam-filled components attain the classification of heavily inflammable with various supplementary properties for the s and d suffixes.

6.1.2 Decorative properties

Besides the functional properties, organic coatings can offer a much richer range of creative advantages.

National Class as per DIN 4102-1	Requirements of construction supervisory body	European class as per DIN EN 13501-1	Additional requirements min. to max.	Contribution to fire load/growth
A1	non-combustible	A1		no contribution to fire load/growth
A2		A2	s1, d0	insignificant contribution to fire load/growth
B1	heavily inflammable	A2	s2, d0–s3, d2	
		B	s1, d0–s3, d2	very limited contribution to fire load/growth
		C	s1, d0–s3, d2	limited contribution to fire load/growth
B2	normal inflammable	D	s1, d0–s3, d2	acceptable contrib. to fire load/growth
		E	s1, d0–s3, d2	acceptable reaction to fire
B3	easily inflammable	F		no performance determined
s1 = no limited smoke production to s3 = unlimited smoke production d0 = no droplet production to d2 = strong droplet production				

Table 3: Fire classification of construction materials according to DIN 4102-1 and DIN EN 13501-1

A comprehensive colour palette allows choice of nearly every custom colour. Combined optimally with various degrees of specular gloss, different structure and embossing of the surface, special creative accents can be obtained.

In addition to functionality, aesthetics and harmony are nearly essential and are a prerequisite of ambitious customers.

Embossed surfaces can be fabricated at coat thicknesses over about 100 µm. The colours shown in the colour cards are reproductions of the original colours and therefore may deviate from them slightly. The embossing examples shown and the film designs in the embossing samples and film cards are meant to convey an impression of the surfaces.

The appearance of the surface will be influenced additionally by the specular gloss, which is specified as matt, low-gloss, satin, semi-gloss, gloss and high-gloss finished.

6.2 Areas of application

Experience has shown that in addition to the product properties cited under clause 6.1, attention must be focussed on various characteristics depending on the intended purpose.

6.2.1 Construction and ancillary construction products

Constructions products and ancillary construction products presently represent the most application for organic coil coated flat products. Specialised materials for use in construction are employed based on long-standing experience and suited to the particular usage.

The coating systems primarily utilised for construction and ancillary construction products are listed in **Table 2**. The properties of the coating systems used have a very high standard of quality and are designed to fulfil the basic requirements of the construction industry with regard to decorative and functional properties.

If special requirements must be met, the suitable selection can be made in coordination with the customer from the diversity of coatings available through suppliers.

Organic coil coated flat products are subject to monitoring for use in application areas regulated by construction supervisory bodies. Responsibility for assuring that the prescribed properties of a corrosion protective coating system are adhered to lies with the coater for standard profiles and with the manufacturer for complex structural components. This procedure presently follows DIN 55928-8 and DIN 55634 in future.

6.2.1.1 Functional properties

Different selected requirements must be met for the behaviour of the coating during finishing and later in use, depending on the specific application. For finishing, the formability, adhesion, hardness, coverability, and compatibility with foam products are the important properties. In contrast, the coat thickness, resistance to influences like heat, weathering, corrosion, abrasion, or the health considerations are important for the behaviour when in use.

Since forming into a finished structural component occurs to the strip after it is coated, an optimum must be found between formability and hardness of the coating accompanied by excellent coating adhesion.

The properties can be selectively extended for a specific application by choice of a suitable coating system, in order to guarantee the necessary properties for finishing such as the coverability, or compatibility of the coating with foam products. By suitable selection of the substrate, the coating, and the coat thickness, organic coil coated flat products can exhibit the desired properties in usage.

6.2.1.2 Decorative properties

The wishes of the customer can be fulfilled very well with regard to colour and specular gloss using liquid coatings; various surface relief appearances can be represented also. With decorative films, a wide spectrum of available colours and designs can be offered depending on the foil supplier program.

Applications		Coating		
		SP	PUR	PUR-PA
Use with building interiors[1]	Partition walls	x		
	Ceiling panels	x		
	Refrigeration room components	x		
	Ship interior finishing	x	x	x
	Profiles, guiderails	x	x	
	Elevators	x		
Use with building exteriors[2]	Roofing profiles	x	x	x
	Roofing tiles	x	x	x
	Sandwich panels	x	x	x
	Wall components	x	x	x
	Edging components	Selection matching with the particular wall and roofing components respectively sandwich panels		
	Products of panel-beater	x	x	x
Ancillary construction products	Doors, gates, windows	x	x	x
	Summer houses	x	x	x
	Specialised applications: Swimming pool cladding, ...	Selection according to prior consultation		

[1] For building interior applications, steel grades S220GD to S350GD or DX51 to DX56 are normally used with Z, ZM, or ZA metallic coatings, or in exceptional cases without metallic coating.

Table 4: Common coatings for construction and ancillary construction products

Potential colour deviations can be avoided by applying material from only one production lot to one structure. This must be taken into account especially when planning larger structures. The steel producers can offer help in advance with this.

6.2.1.3 Application examples and typical coating systems

In **Table 4** below, the common coatings are listed according to area of application for building interiors, building exteriors and ancillary products.

Coating					
HDP	**HDP-PA**	**PVDF**	**PVC(P)**	**PVC(F)**	**SP-PET(F)**
				x	x
					x
				x	x
				x	x
				x	x
x	x	x	x	x	
x	x	x	x		
x	x	x	x	x	
x	x	x	x	x	
Selection matching with the particular wall and roofing components respectively sandwich panels					
x	x	x	x		
x	x	x	x	x	x
x	x	x	x	x	
Selection according to prior consultation					

[2] For building exterior application, steel grades S220GD to S350GD or DX51 to DX56 are normally employed with Z, ZM, ZA, or AZ metallic coatings.

6.2.1.4 Special requirements

Organic coated flat products must meet very specialised requirements, depending on application.

Building interior application:

- Partition walls: flatness, corrosion and chemical resistance for special applications, colour stability
- Ceiling panels: punching quality, adhesion of protective film
- Profiles, guiderails: forming stress, paint adhesion requirements

Building exterior application:

- Roofing profiles, roofing tiles: weathering stability (corrosion and UV stability) primarily in combination with colours typically used in the roof area, forming stress for roofing tiles, scratch resistance
- Sandwich panels: colour stability, flatness of smooth sandwich panels, thermal insulation, fire protection
- Wall components: colour stability, corrosion or chemical resistance, paint adhesion, coverability
- Products of panel beater: Freedom from coil breaks, corrosion resistance, scratch resistance

Ancillary construction products:

- Doors, gates: Formability, paint adhesion, corrosion resistance and weather resistance
- Specialised applications: arrangements to be clarified between customer and steel producer for the specific case

6.2.2 Domestic appliances / home entertainment electronics / lighting

Besides construction and ancillary construction products, these products represent an important use for organic coil coated flat products. Specialised materials have developed from practically all the substrates.

Typical properties	Domestic appliances	Home electronics	Lighting
Coating	Paint: polyurethane, polyester Film: PVC Paint/film (co-laminate): polyester, polyurethane/PET, PP-PET	Paint: polyester, polyurethane as well as polyamide modified polyester and polyurethane, Film: PVC	Paint: polyester
Coating thickness [µm]	Paint: 25–30 Film: 80–120 Paint/film (co-laminate): 50–70	Paint: 20–30 Film: 100–150	Paint: 15–35
Colour Specular gloss Substrate material	white, metallic high gloss finished Z, ZA, ZE, not surface coated	black, silver, beige matt ZE, ZA, Z	white gloss finished Z, ZA, not surface coated

Table 5: Application examples and typical properties of composite materials

Requirements											
Finishing	**C**	**W**	**H**	**Usage**	**C**	**W**	**H**	**Environmental**	**C**	**W**	**H**
Adhesion of the coating	x	x	x	Adhesion of the coating	x	x	x	Free of harmful substances as per RoHS[1)]	x	x	x
Formability	x	x	x	Specular gloss and colour	x	x	x				
Joining performance	x	x	x	surface structure	x	x	x				
Foam adhesion on the reverse side	x			Corrosion resistance	x	x	x				
				Surface hardness	x	x	x				
				Resistance to heat		x	x				
				Resistance to staining	x		x				
				Alkali resistance		x					
				Resistance to UV light	x	x	x				

Explanatory notes: C = refrigerator
W = washing machine, dishwasher, dryer
H = cooker, etc.

x = requirement fulfilled

[1)] EU guideline 2002/95/EG, RoHS (Reduction of Hazardous Substances), compulsory since 1 July 2006

Table 6: Requirements of composite material for domestic appliances

In the case of paint coatings, this involves polyester and polyurethane. The pigments correspond to the typical colour choices respectively. Colourful paints are also increasingly used. The same is true for the films of coil coated materials. The specular gloss follows consumer taste. All coatings must be designed in conjunction with the substrates to be highly flexible. They are therefore tailored to forming processes like swing-folding, roll forming, and deep drawing as well as to joining techniques like clinching and punch riveting.

Coil coated material fulfils the current requirements of the appliance and lighting manufacturers for the appropriately suited production equipment **(Table 5).**

6.2.2.1 Domestic appliances

The properties of organic coil coated material comprise numerous characteristics. For cold, wet, and warm applications (refrigeration/washing-rinsing-drying/cooking) involving various domestic appliances (many times labelled as “white goods”), the properties are weighted differently (**Table 6**).

The paint coatings have attained a high standard of quality. Besides the distinct flexibility, they possess, for example, almost no tendency to stain due to mustard, red wine, shoe polish, etc. Further, the surface structure can be varied to a certain extent (orange peel). White is still the predominant colour for domestic appliances, however coil coated material with coloured or metallic paints is being provided increasingly often.

In addition to paint coatings, films are being utilised as well. Decorative films primarily involve PVC-films. They exhibit a high degree of resistance to wear. Special aesthetic effects can be achieved using printed films. The same hold true for PVC-polyester composite films.

Special properties are attained through paint-film combinations (co-laminates). In this way, an excellent chemical and scratch resistance obtains through a clear cover film on top of a paint layer that lends colour. Further, a high level of brilliance is achieved.

6.2.2.2 Home electronics

This product group comprises housings for electronic entertainment equipment and computers, that are frequently still described as "brown goods". Paints or films are utilised as coatings. Paint coatings have won the largest market share in the last several years. The specular gloss of the flat products is low to extremely low for the home electronics area. The colours run from black to silver to gold at present. The paint systems are resistant to marking and fingerprints. The same holds true for coil coated materials of the computer housings. In the meantime, colourful metallic coatings have become options here as well. The reverse side of the material is uncoated as a rule due to the electromagnetic shielding necessary, but can also be coated with conductive backing coat.

6.2.2.3 Lighting

Special polyester-based paints are used that exhibit very high formability. The resistance to heat and UV light are very good so that only very small changes to colour and specular gloss occur in this application. Reflectance of up to 90% can be achieved. Due to the extensive requirements, films are ruled out as coatings at present.

The reverse side of flat products is furnished with a reverse side paint coat. However, a coating with the paint system of the (effective) top side is possible.

6.2.3 Vehicle fabrication

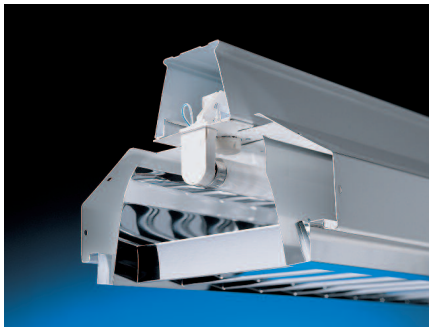
6.2.3.1 Corrosion protection primer in automobile body fabrication

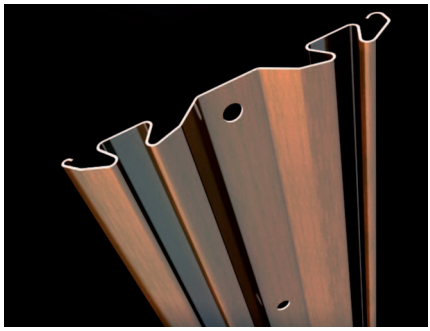
Weldable corrosion protection primer applied one-side or two-side are especially worthy of mention – also called thin film coats, which are chiefly used in automobiles as present. In combination with metallic coatings and specially matched pre-treatments, they lead to composite materials with improved properties. The cathodic protection of the zinc layer is bound to the organic coating with its barrier effect, abrasion resistance, elasticity, and low-friction properties. These "Duplex systems" are thus well suited to fulfil the demands of the automobile industry following the advanced development of this corrosion protection concept.

Corrosion-protected steel sheet makes a significant contribution to vehicle safety, environmental protection, and economical manufacturing. It also allows for the extension of guaranty agreements beyond those of today:

Freestanding refrigerator/freezer combination with organic coated steel sheet housing

Back side of a flat screen TV





Sliding door guiderails from continuously organic coated (coil coated) sheet steel (above) and housings for fluorescent lighting fixtures (above left)

Refrigerated trailer with multiple-layer paint/film applied externally and film coating suitable for foodstuffs applied internally

- The corrosion protection in hollow spaces within the car body, folds, and flanges is significantly improved and thereby increases the retained value of the vehicle. The operational life and recycling period are thereby considerably extended.
- Vehicle safety is retained for crash-critical component groups over the entire operating life. This is all the more important the smaller the used sheet thicknesses are, e.g. with higher strength steel grades.

Substrates are preferably one-side or two-side electrolytically zinc-coated sheet steel (ZE) with zinc coatings of 5 to 7,5 µm; the combination with hot-dip zinc coated sheet steel (Z) is generally feasible as well, but not used in mass production at present. These are one-side or two-sided chromium-free pre-treated and coated with corrosion protection primer.

The corrosion protection primers employed differ from one another in their composition, in particular with regard to the conductive pigments and the coat thicknesses which can be achieved. With regard to corrosion performance, there are two different systems known as 1st Generation and 2nd Generation. **Fig. 4** shows typical examples of structures.

1st Generation corrosion protection primers exhibit a three- to four-times improvement of barrier protection compared to purely metallic coatings in accelerated laboratory weathering (e.g. VDA 621-415) as well as in accelerated outdoor exposure (VDA 621-414). A typical corrosion test result on test flanges is depicted in **Fig. 5.**

The barrier protection can be doubled again by employing 2nd Generation systems. Further information is contained in publication 122 – E: Weldable Corrosion Protection Primer – Thin Film Coated Steel Sheets for the Automotive Industry" from the Stahl-Informations-Zentrum.

6.2.3.2 Utility and rail vehicles

Various organic coil coated materials are employed here depending on the requirements. The range here extends

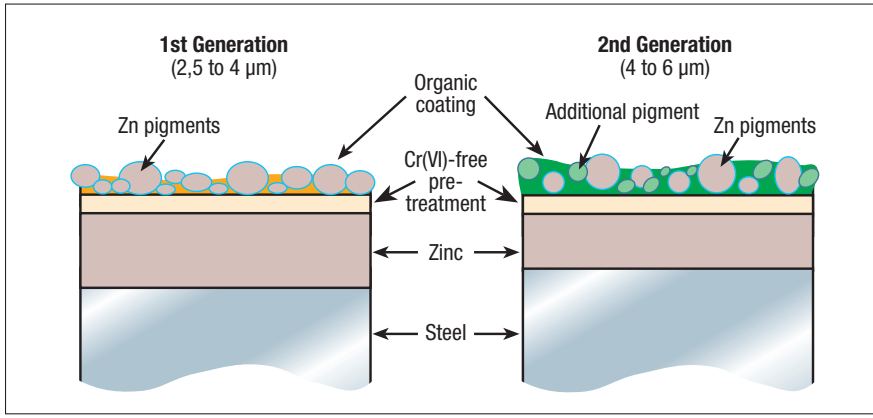


Fig. 4: Schematic setup of a corrosion protection primer on zinc coated steel sheet

from primer-coated to final-coated flat products.

In truck construction, the variation of coating type extends from conventional two-layer coats through four-coat systems to paint-film-paint combinations. The complex coatings in particular fulfil the stringent demands for corrosion resistance, weathering durability, wear resistance, and immunity to contamination, and soiling; sandwich-construction walls of refrigerated trailers are one of their preferred uses. The typical colour is white, but other colours are utilised as well. Specular gloss is mainly preferred in the high- and mid-range. Hot-dip coated sheet steels are used as the substrates. PVC-laminated sheet steel is employed for the inner skin of the sandwich. These coatings are suitable for use in the foodstuffs branch in accordance with the German Foods and Other Commodities Act (Lebensmittel- und Bedarfsgegenständegesetz – LMBG) and corresponding certifications are available.

Coil coated flat products with film and/or paint coatings are suitable for interior construction of railway wagons. Aesthetic as well as functional requirements, such as wear resistance for example, are fulfilled.

6.2.4 Miscellaneous applications

Besides the main applications described above, the organic coil coated flat product is also employed in the following areas:

- Technical packaging
- Domestic applications for the interior and exterior
- Furniture, interior decor and office equipment
- Signpost

Due to the breadth of applications, an exchange between the customer and steel producer is indispensable (see Chapter 11).

6.2.4.1 Technical packaging

The utilisation in this field is diverse and extends from barrel lids to large-format industrial packaging. Quite diverse substrates are employed as a result. The

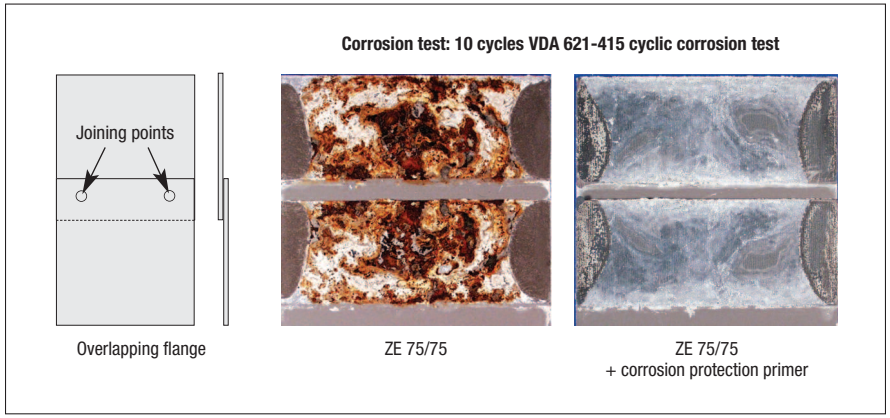


Fig. 5: Corrosion behaviour of sheet metal bodywork with corrosion protection primer on flanged test joints (open flange)

Intended end-use	Substrate		Coating	
	Type	Thickness mm	Type	Nom. thickness µm
Barrel lids, -bottoms	not surface coated, Z	1,0	Specialised epoxy polyester polyester plus PE film	20 20 120
Packet brackets	Z	≥ 1,0	polyester	15

Table 7: Typical application examples in the field of technical packaging

coating is applied to cold rolled steel sheet or surface coated steel sheets, depending on field of application. The thicknesses of the substrates usually lie between 0,2 and 1,5 mm. Two typical examples are shown in **Table 7.**

Stringent requirements for durability in respect of specific chemicals and other materials are fulfilled by specialised coatings, depending on the intended purpose.

6.2.4.2 Building services

Organic coil coated flat products are mainly utilised for boiler housings as well as for heatings and air conditioners. Furthermore, conductor channels and electrical equipment housings are some examples for which the material is suited.

Polyester coatings are generally employed. Film coated flat product is also employed in this area. Specialised paint coatings on hot-dip aluminium-coated sheet steel are used to meet more stringent requirements for heat resistance.

6.2.4.3 Furniture, as well as interior decor and office equipment

Examples of applications for continuously organic coil coated flat product range from steel furniture to steel racks as well as from curtain rails and clothing rails to marker boards. The coatings exhibit a balanced relationship between functionality and aesthetics.

They involve paints or films. They exhibit the durability necessary for daily use. The paints are typically specialised polyester. PVC films and composite films are used with the film-coated materials. The films are available unichrome or simulated wood grain for example – usually in decoratively embossed surface finishes.

6.2.4.4 Signpost

Organic coil coated flat product is an optimal composite material for this intended purpose. The material is suited to printing using different techniques as well as attaching reflective films as one example and is well suitable for varnishing. The areas in which it is used extend from road signs to billboards. The coat-

ings are selected specially for the various applications. Polyester is employed as a typical paint. Preferred substrates usually involve zinc coated sheet steel in different variations.

6.3 Backing coats

Normally the properties of the backing coats are only of minor importance. They most serve to (temporarily) protect the reverse side from corrosion. Due to the low thickness of the film (about 5–10 µm), this corrosion protection is very limited and not suitable for exterior applications. In addition, the backing coat protects the coated top side from damage in the coil or changes to the surface topography. The steel producer matches the reverse side paint to the requirements of the top side coating.

Backing coats are available in several, mostly muted colours; exact colour matching is not guaranteed however, due to the limited covering ability of the thin coating.

Despite the already mentioned restrictions, a backing coat must fulfil numerous requirements that are often not addressed in the order. For example, the entire coating system must withstand processing without damage or abrasion during the forming stage (usually during profiling). In cases of demanding forming processes, the backing coat should be optimised with respect to its tribological properties and its flexibility.

Frequently, backing coats are used as an adhering coat during the manufacture of sandwich panels. The steel producers offer specialised paint systems for this, which have been proven in the field. Nevertheless, no general assurance can be give on behalf of the steel producers for successful processing results because of the multitude of foam injection systems employed and the large influence the process parameters have during injection of the foam. In practice, the procedure has been proven viable by delivering small samples to test the suitability of the backing coat in the respective foam injection process. Steel producers, foam manufacturers, as well as foam processors ensure that changes to the respective product compositions and processing parameters are only carried through after mutual agreement and follow-up testing. Only this kind of procedure can ensure that the final product retains the consistent level of quality. The same holds true for construction components where mineral wool must be glued to the backing coat; in this case, the reaction at the interface between the reverse side protective paint and the adhesive must be tested in advance.

Backing coats are monitored less closely than the visible two-layer or multiple-layer paint coats due to their subordinated visual properties.

If the spectrum of requirements for the backing coat is diverse, often only using a single-coat system can be considered, which offers more potential due to its higher coating thickness (10–15 µm). The steel producer will recommend a single-coat finish as needed after receiving the profile of requirements.

7 Test methods

Coil coated flat product is subject to careful quality assurance inspection at the manufacturer's plant. The manufacturing facilities are certified in accordance with DIN EN ISO 9000 sections.

Online measurement processes serve to regulate or control the corresponding properties of the coating material process. The specification of the individual properties takes place through standardised offline processes. The quality confirmation is carried out based on the offline and online processes. In this way, a high level of quality over the full length and width of the strip is ensured.

7.1 Online test methods

7.1.1 Continuous measurement of coating thickness

An indispensably useful technique in the coil coating industry is the continuous measurement and permanent recording of the wet and dry film thickness of the running strip. It takes place without contact, i.e. non-destructively, with one or if needed two travelling sensor heads on both sides, located directly at the coating stations. The parameters of the coatings (material data and information about the coating thickness target), but also the roll settings (roll pressure and speed), are monitored as part of the process parameters by a supervisory process-control computer. In this way, a reproducible and high level of quality can be attained. This is especially important for lines with a high processing speed. Prerequisite for this therefore is rapid measurement acquisition.

Two processes shown to be effective are important to mention here.

- A radiometric process using beta backscattering:
  A detector measures the secondary radiation from the steel substrate or zinc coated steel on the one hand, and the paint layer or both paint layers (primer and topcoat) on the other. The effects of the substrate and the paint layer(s) are measured separately.
- Photo-thermal process:
  The light emitted by a CO_2 laser and absorbed in the paint layer creates thermal waves. The increase and decrease of the temperature produces a signal that is captured by an infrared (IR) detector. The substrate has no influence on this.

7.1.2 Online colorimetry

Organic coil coated flat products as a rule have a finished surface corresponding to customer wishes and specifications concerning the finish. The colour of the organic coating is therefore one of the important quality criterias. The colour is usually adjusted with the aid of a colour sample, such as RAL 840 HR colour cards or customer colour standards for example. The steel producers and paint or varnish suppliers ensure that reliable quality management is applied in the case of this characteristic as well.

The selection of the colour components and the processing of the paints and varnishes during their manufacturing as well as intensive quality audits by the suppliers produce a foundation for the careful colouration of the coil coated flat products. These actions receive significant support through agreed delivery and acceptance of goods at the steel producer and a colour measurement of the flat products.

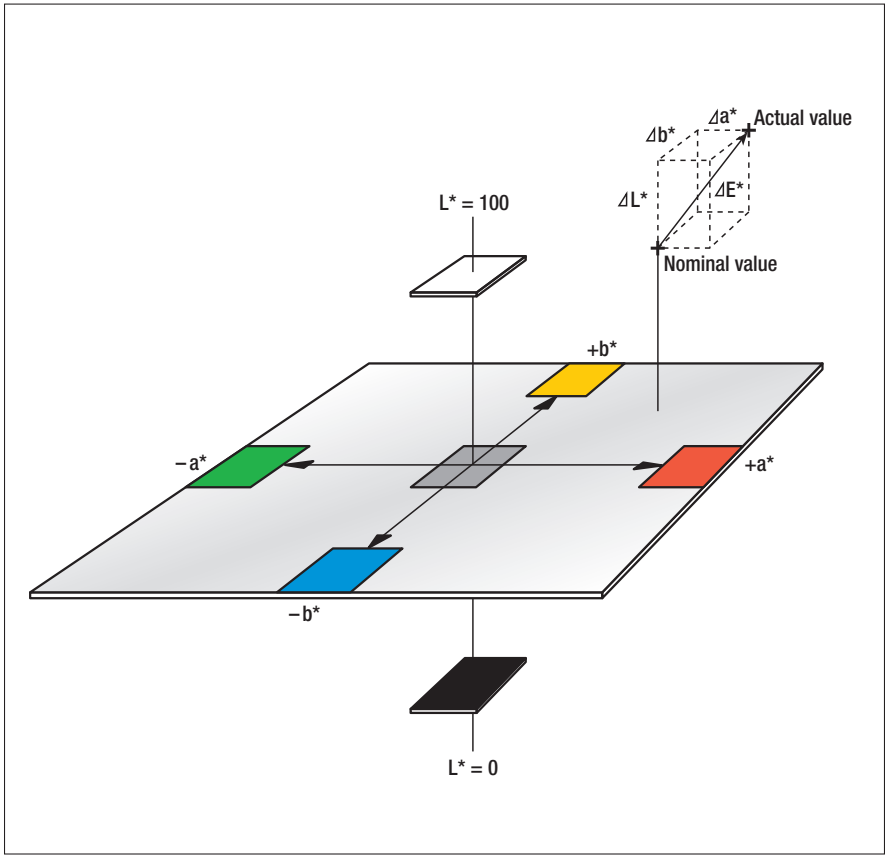


Fig. 6: Colorimetric values L*, a* und b*

A colour measurement is understood to be an objective determination of three concrete colorimetric values for unambiguous identification of a coloured surface. Initially, what are known as the X, Y and Z tristimulus values (ISO 7724-1) are determined, whereby an average value of human colour perception for the primary colours red, green, and blue is taken into account by curves of the tristimulus value (ISO 7724-1). A mathematical transformation is used to calculate the colorimetric values from these measurements for various colour systems. The most widely used is the CIELAB formula (DIN EN ISO 11664) with the colour values L*, a* and b*, **Fig. 6.** These figures stand for the lightness as well as the red-green and yellow-blue weighting. The colour difference ΔE* (ISO 7724-3) can be calculated from the three colourimetric values.

Colorimeters have different measurement geometries and light sources. As a rule, measurement geometry of 45°/0° and D65 standard light type (ISO 7724-2) is selected for assessing colours. In addition, a geometry known as diffuse/8° and other light sources type such as F2 (DIN 6172) are utilised, for example.

The colorimeters are usually spectral photometers that cast light upon the coating material surface. The reflected light is split into its spectral components, measured and recorded. The recorded reflection values are mathematically converted into tristimulus values or other colorimetric values.

The measurement equipment installed online is different from the offline laboratory equipment due to a great distance from the measuring unit to the surface of the flat products. It permits excellent colour inspection of the running strip whereby a precise colour determination is obtained.

7.2 Material inspections

The choice and range of inspections are matched to the properties of the coil coated strip that are requested and follow the applicable standards and proven processes. Besides the test methods for shelf life (see clause 7.2.5), the values set out in DIN EN 23270 apply for temperature and atmospheric humidity during preparation and execution.

The upper and lower limiting values of the listed properties that must be adhered to can be agreed at the time of order, taking into consideration each of the applicable test methods. All measurements should be carried out as comparative check against the agreed normal value when possible. A summary is provided below, which is also referred to in DIN EN 10169.

7.2.1 Thickness of coating

DIN EN 13523-1: Film thickness

DIN EN ISO 2808: Paints and varnishes – determination of the film thickness (applicable per agreement)

- Addendum to DIN EN 10169:
  For products in widths ≥ 600 mm, testing of the coating thickness shall be carried out at three measuring sites located perpendicular to the roll direction, i.e. in the centre and at a distance of at least 50 mm from either edge of the product (“triple spot test”).
  For products in widths of < 600 mm, testing shall only be carried out at one site in the centre of the product (“single spot test”).

7.2.2 Appearance

Colour/colour difference

Instrumental: DIN EN 13523-3:

Colour difference – instrumental comparison

- Not applicable for fluorescent samples, samples with pronounced metamerism, multicoloured samples, samples with metallic or pearl lustre.

Visual: DIN EN 13523-22:

Colour difference — Visual comparison

- The conformity of the coating colour, and that of the design in the case of printed surfaces, is determined by a visual comparison with an agreed sample.
- A more exact inspection consists of an instrumentation measurement of the colour difference between the product delivered and the referenced standard in accordance with DIN EN 13523-3.

Note: Colour differences produced by colorimetry can effect the visual colour perception of the viewer quite differently – depending on the particular colour.

The following procedures are therefore included in the colorimetric tolerance agreements between the customer and the supplier:
- Determination of a coil coating colour standard (reference)
- Thorough examination of the reproducibility of the measurement results
- Thorough examination of the correlation between the measurements of the measuring equipments used

Table 16 (pages 48 to 54) provides a summary of the RAL colours for the coil coating process.

Metamerism
DIN EN 13523-15: Metamerism
- Not applicable for samples with fluorescent, metallic, pearlescent coatings, and multicoloured samples.

Specular gloss
DIN EN 13523-2: Specular gloss
- Also applicable with samples having metallic or pearlescent lustre; estimates only for textured samples

7.2.3 Coating hardness

Pencil hardness
DIN EN 13523-4: Pencil hardness
- Limited accuracy with textured samples

Resistance to scratching
DIN EN 13523-12:
Resistance to scratching
- Limited for samples having soft or conductive coatings or textured samples

Buchholz indentation test
DIN EN ISO 2815: Paints and varnishes – Buchholz indentation test
- In the case of coatings with thicknesses greater than 50 µm, thin carbon paper laid underneath the indentation tool gives a more precise record of the original indentation.
- Only applicable by agreement with embossed or textured coatings

7.2.4 Adhesion/flexibility

Adhesion and resistance to crack formation on rapid deformation
DIN EN 13523-5: resistance to rapid deformation (impact test)
- No predictive value for samples having film thicknesses > 60 µm

Adhesion after indentation
DIN EN 13523-6: Adhesion after indentation (cupping test)

Flexibility/bendability (T-Bend)
DIN EN 13523-7: Resistance to cracking on bending (T-bend test)
ASTM D 4145: Standard Test Method for Coating Flexibility of Prepainted Sheet

7.2.5 Shelf life

Resistance to salt spray (fog)
DIN EN 13523-8: Resistance to salt spray (fog)

Behaviour on artificial weathering
DIN EN 13523-10: Resistance to fluorescent UV light and water condensation
- Limited correlation of results with natural weathering

Manor house in Denmark with anthracite steel pantiles

Combination of different construction components (above) and apartment building with facades of organic coated construction components in Vienna, Austria (right)

Façade of an automobile dealer in Hinterkappelen, Switzerland

Roofing and gutter system of organic coil coated steel sheet

Research facility
with high gloss façade
components

Elevating doors of
organic coil coated
flat products (above)
as well as roofing and
edge components of a
farm house (above left)

Wall components for
production and adminis-
tration buildings

Resistance to chalking

DIN EN 13523-14: Chalking (Helmen method)

- Not applicable to samples with embossed coatings, limited for samples with textured coatings. The measurement result is influenced by sediment material.

ASTM D 4214: Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films

Behaviour in outdoor weathering

DIN EN 13523-19: Panel design and method of atmospheric exposure testing

DIN EN 13523-21: Evaluation of outdoor exposure panels

DIN EN ISO 6270-1: Paints and varnishes – Determination of resistance to humidity – Part 1: Continuous condensation

DIN EN ISO 11997-1: Paints and varnishes – Determination of resistance to cyclic corrosion conditions – Part 1: Wet (salt fog)/dry/humidity

See also: DIN EN ISO 12944-2: Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 2: Classification of environments

7.2.6 Additional testing procedures

DIN EN 13523:
Coil coated metals – Test methods

DIN EN 13523:0
General introduction and list of test methods

DIN EN 13523-9:
Resistance to water immersion

DIN EN 13523-11:
Resistance to solvents (rubbing test)

DIN EN 13523-13:
Resistance to accelerated ageing by the use of heat

DIN EN 13523-16:
Resistance to abrasion

DIN EN 13523-17:
Adhesion of strippable films

DIN EN 13523-18:
Resistance to staining

DIN EN 13523-20:
Foam adhesion

DIN EN 13523-23:
Colour stability in humid atmospheres containing sulphur dioxide

DIN EN 13523-24:
Resistance to blocking and pressure marking

DIN EN 13523-25:
Resistance to humidity

DIN EN 13523-26:
Resistance to condensation of water

DIN EN 13523-27:
Resistance to humid poultice (Cataplasm test)

DIN EN 13523-29:
Resistance to environmental soiling (Dirt pick-up and striping)

7.2.7 Test regulations for evaluation of weldable corrosion protection primers

Stahl-Eisen-Prüfblatt (SEP) 1160: Evaluation of Weldable Corrosion Protection Primers for the Automotive Industry, bilingual edition (G, E), publisher: Stahlinstitut VDEh

- Part 1: Corrosion performance
- Part 2: Measurement of coating weight
- Part 3: Adhesion behavior
- Part 4: Peel-off behavior
- Part 5: Adhesive bonding properties
- Part 6: Suitability for electrodeposition painting
- Part 7: Procedure for quantitative determination of welding fumes from resistance spot welding

7.2.8 Miscellaneous properties

Miscellaneous properties that can play a role depending on intended purpose, such as coverability, suitability for bonding, resistance to chemicals and staining substances, reaction to fire, resistance to heat, and behaviour during deep drawing for example, as well as the suitable test methods should be particularly agreed to between the supplier and the customer.

Note: The inspection of properties in accordance with 7.2.5 to 7.2.7 is a basic part of the on-going inspection programme.

8 Dimensions, allowable tolerances on dimensions and shape

The standard tolerances on dimensions and shape are listed in the following clauses. Special tolerances can be arranged with the steel producers. These standards form the basis for the following summaries:

DIN EN 10131:2006
EN 10131, Cold rolled uncoated and zinc or zinc-nickel electrolytically coated low carbon and high yield strength steel flat products for cold forming – Tolerances on dimensions and shape

DIN EN 10143:2006
EN 10143, Continuously hot-dip coated steel sheet and strip – Tolerances on dimensions and shape

The reader should check the most current version of the standards beforehand.

8.1 Thickness

8.1.1 Substrate thickness

Table 8 specifies the preferred nominal thicknesses (order thickness) for all the substrates as well as the allowable thickness tolerances:

A cold rolled flat product and electrolytically coated flat product with a minimum yield strength of R_e < 260 MPa (applicable standard: DIN EN 10131: 2006)

B cold rolled flat product and electrolytically coated flat product with a minimum yield strength of 260 MPa ≤ R_e < 340 MPa (applicable standard: DIN EN 10131:2006)

C cold rolled flat product and electrolytically coated flat product with a minimum yield strength of 340 MPa ≤ R_e ≤ 420 MPa (applicable standard: DIN EN 10131:2006)

D cold rolled flat product and electrolytically coated flat product with a minimum yield strength of 420 MPa < R_e (applicable standard: DIN EN 10131:2006)

E hot-dip coated flat products for cold forming with a minimum yield strength R_e or minimum proof strength of $R_{p0,2}$ < 260 MPa (applicable standard: DIN EN 10143:2006)

F hot-dip coated flat products for cold forming with a minimum proof strength of 260 MPa ≤ $R_{p0,2}$ < 360 MPa as well as for steel grades DX51D and S550GD (applicable standard: DIN EN 10143:2006)

G hot-dip coated flat products for cold forming with a minimum proof strength of 360 MPa ≤ $R_{p0,2}$ ≤ 420 MPa (applicable standard: DIN EN 10143:2006)

H hot-dip coated flat products for cold forming with a minimum proof strength of 420 MPa ≤ $R_{p0,2}$ ≤ 900 MPa (applicable standard: DIN EN 10143:2006)

Nominal thickness	Normal tolerances for nominal widths			Special tolerances (S) for nominal widths		
mm	≤ 1200	> 1200 ≤ 1500	> 1500	≤ 1200	> 1200 ≤ 1500	> 1500
≥ 0,35 ≤ 0,40						
A	± 0,03	± 0,04	± 0,05	± 0,020	± 0,025	± 0,030
B	± 0,04	± 0,05	± 0,06	± 0,025	± 0,030	± 0,035
C	± 0,04	± 0,05	± 0,06	± 0,030	± 0,035	± 0,040
D	± 0,05	± 0,06	± 0,07	± 0,035	± 0,040	± 0,050
E	± 0,04	± 0,05	± 0,06	± 0,030	± 0,035	± 0,040
F	± 0,05	± 0,06	± 0,07	± 0,035	± 0,040	± 0,045
G	± 0,05	± 0,06	± 0,07	± 0,040	± 0,045	± 0,050
H	± 0,06	± 0,07	± 0,08	± 0,045	± 0,050	± 0,060
> 0,40 ≤ 0,60						
A	± 0,03	± 0,04	± 0,05	± 0,025	± 0,030	± 0,035
B	± 0,04	± 0,05	± 0,06	± 0,030	± 0,035	± 0,040
C	± 0,05	± 0,06	± 0,07	± 0,035	± 0,040	± 0,050
D	± 0,05	± 0,07	± 0,08	± 0,040	± 0,050	± 0,060
E	± 0,04	± 0,05	± 0,06	± 0,035	± 0,040	± 0,045
F	± 0,05	± 0,06	± 0,07	± 0,040	± 0,045	± 0,050
G	± 0,06	± 0,07	± 0,08	± 0,045	± 0,050	± 0,060
H	± 0,06	± 0,08	± 0,09	± 0,050	± 0,060	± 0,070
> 0,60 ≤ 0,80						
A	± 0,04	± 0,05	± 0,06	± 0,030	± 0,035	± 0,040
B	± 0,05	± 0,06	± 0,07	± 0,035	± 0,040	± 0,050
C	± 0,06	± 0,07	± 0,08	± 0,040	± 0,050	± 0,060
D	± 0,06	± 0,08	± 0,10	± 0,050	± 0,060	± 0,070
E	± 0,05	± 0,06	± 0,07	± 0,040	± 0,045	± 0,050
F	± 0,06	± 0,07	± 0,08	± 0,045	± 0,050	± 0,060
G	± 0,07	± 0,08	± 0,09	± 0,050	± 0,060	± 0,070
H	± 0,07	± 0,09	± 0,11	± 0,060	± 0,070	± 0,080
> 0,80 ≤ 1,00						
A	± 0,05	± 0,06	± 0,07	± 0,035	± 0,040	± 0,050
B	± 0,06	± 0,07	± 0,08	± 0,040	± 0,050	± 0,060
C	± 0,07	± 0,08	± 0,10	± 0,050	± 0,060	± 0,070
D	± 0,08	± 0,10	± 0,11	± 0,060	± 0,070	± 0,080
E	± 0,06	± 0,07	± 0,08	± 0,045	± 0,050	± 0,060
F	± 0,07	± 0,08	± 0,09	± 0,050	± 0,060	± 0,070
G	± 0,08	± 0,09	± 0,11	± 0,060	± 0,070	± 0,080
H	± 0,09	± 0,11	± 0,12	± 0,070	± 0,080	± 0,090

Table 8: Allowable thickness tolerances in accordance with DIN EN 10131 (A–D) and DIN EN 10143 (E–H)

Nominal thickness	Normal tolerances for nominal widths			Special tolerances (S) for nominal widths		
mm	≤ 1200	> 1200 ≤ 1500	> 1500	≤ 1200	> 1200 ≤ 1500	> 1500
> 1,00 ≤ 1,20						
A	± 0,06	± 0,07	± 0,08	± 0,040	± 0,050	± 0,060
B	± 0,07	± 0,08	± 0,10	± 0,050	± 0,060	± 0,070
C	± 0,09	± 0,10	± 0,11	± 0,060	± 0,070	± 0,080
D	± 0,10	± 0,11	± 0,13	± 0,070	± 0,080	± 0,100
E	± 0,07	± 0,08	± 0,09	± 0,050	± 0,060	± 0,070
F	± 0,08	± 0,09	± 0,11	± 0,060	± 0,070	± 0,080
G	± 0,10	± 0,11	± 0,12	± 0,070	± 0,080	± 0,090
H	± 0,11	± 0,13	± 0,14	± 0,080	± 0,090	± 0,110
> 1,20 ≤ 1,60						
A	± 0,08	± 0,09	± 0,10	± 0,050	± 0,060	± 0,070
B	± 0,09	± 0,11	± 0,12	± 0,060	± 0,070	± 0,080
C	± 0,11	± 0,12	± 0,14	± 0,070	± 0,080	± 0,100
D	± 0,13	± 0,14	± 0,16	± 0,080	± 0,100	± 0,110
E	± 0,10	± 0,11	± 0,12	± 0,060	± 0,070	± 0,080
F	± 0,11	± 0,13	± 0,14	± 0,070	± 0,080	± 0,090
G	± 0,13	± 0,14	± 0,16	± 0,080	± 0,090	± 0,110
H	± 0,15	± 0,16	± 0,18	± 0,090	± 0,110	± 0,120
> 1,60 ≤ 2,00						
A	± 0,10	± 0,11	± 0,12	± 0,060	± 0,070	± 0,080
B	± 0,12	± 0,13	± 0,14	± 0,070	± 0,080	± 0,100
C	± 0,14	± 0,15	± 0,17	± 0,080	± 0,100	± 0,110
D	± 0,16	± 0,17	± 0,19	± 0,100	± 0,110	± 0,130
E	± 0,12	± 0,13	± 0,14	± 0,070	± 0,080	± 0,090
F	± 0,14	± 0,15	± 0,16	± 0,080	± 0,090	± 0,110
G	± 0,16	± 0,17	± 0,19	± 0,090	± 0,110	± 0,120
H	± 0,18	± 0,19	± 0,21	± 0,110	± 0,120	± 0,140
> 2,00 ≤ 2,50						
A	± 0,12	± 0,13	± 0,14	± 0,080	± 0,090	± 0,100
B	± 0,14	± 0,15	± 0,16	± 0,100	± 0,110	± 0,120
C	± 0,16	± 0,18	± 0,19	± 0,110	± 0,120	± 0,130
D	± 0,19	± 0,20	± 0,22	± 0,130	± 0,140	± 0,160
E	± 0,14	± 0,15	± 0,16	± 0,090	± 0,100	± 0,110
F	± 0,16	± 0,17	± 0,18	± 0,110	± 0,120	± 0,130
G	± 0,18	± 0,20	± 0,21	± 0,120	± 0,130	± 0,140
H	± 0,21	± 0,22	± 0,24	± 0,140	± 0,150	± 0,170

Explanatory notes see page 36

Nominal thickness	Normal tolerances for nominal widths			Special tolerances (S) for nominal widths		
mm	≤ 1200	> 1200 ≤ 1500	> 1500	≤ 1200	> 1200 ≤ 1500	> 1500
> 2,50 ≤ 3,00						
A	± 0,15	± 0,15	± 0,16	± 0,100	± 0,110	± 0,120
B	± 0,17	± 0,18	± 0,18	± 0,120	± 0,130	± 0,140
C	± 0,20	± 0,20	± 0,21	± 0,130	± 0,140	± 0,150
D	± 0,22	± 0,23	± 0,24	± 0,160	± 0,170	± 0,180
E	± 0,17	± 0,17	± 0,18	± 0,110	± 0,120	± 0,130
F	± 0,19	± 0,20	± 0,20	± 0,130	± 0,140	± 0,150
G	± 0,22	± 0,22	± 0,23	± 0,140	± 0,150	± 0,160
H	± 0,24	± 0,25	± 0,26	± 0,170	± 0,180	± 0,190

Explanatory notes for Table 8:

For wide strip and strip slit lengthwise, the thickness tolerance in the region of the cold rolled welds may be increased by a maximum of 50% over a length of 10 metres.

This increase is applicable to thicknesses and – unless otherwise agreed at the time of order – to the lower as well as the upper limiting values of the normal and special thickness tolerances.

Table 8, continued: Allowable thickness tolerances in accordance with DIN EN 10131 (A–D) and DIN EN 10143 (E–H)

8.1.2 Coating thickness

The nominal thicknesses of the various coatings are set down either based on the state of the art or they derive from the arrangements between customer and manufacturer.

In accordance with DIN EN 10169, the allowable tolerances for the individual coatings shown in **Table 2** shall be those for the nominal film thicknesses represented in **Table 9.**

Range of nominal thickness µm	> 10 ≤ 20	> 20 ≤ 25	> 25 ≤ 35	> 35 ≤ 60	> 60 ≤ 100	> 100 ≤ 150	> 150 ≤ 500	> 500 ≤ 800
Minus tolerance on the average of three measurements in µm	3	4	6	8	15	20	30	40
Minus tolerance on the single measurement in µm	4	5	8	12	20	25	35	50

Table 9: Tolerances for the nominal thickness in accordance with DIN EN 10169

Nominal width w	Normal tolerances		Special tolerances (S)	
	Upper Deviation A mm	Upper Deviation B mm	Upper Deviation A mm	Upper Deviation B mm
w ≤ 1200	+4	+5	+2	+2
1200 < w ≤ 1500	+5	+6	+2	+2
1500 < w ≤ 1800	+6	+7	+3	+3

Table 10: Allowable tolerances in nominal width for strip and sheet as per DIN EN 10131 (A) and DIN EN 10143 (B)

Requirements for the upper limiting value of the coating thickness are not set down and can be arranged at the time of order. There are no conventions for the backing coat.

8.2 Width

The values given in **Table 10** for allowable tolerances in nominal width apply for strip and sheet.

In principle, actual widths may not fall short of the nominal width.

For strip slit lengthwise and bars cut from it < 600 mm wide, the values given in **Table 11** apply for the allowable excess in nominal width.

In principle, actual widths may not fall short of the nominal width.

Tolerance class	Nominal thickness mm	Nominal width < 125 mm Upper Deviation	Nominal width ≥ 125 < 250 mm Upper Deviation	Nominal width ≥ 250 < 400 mm Upper Deviation	Nominal width ≥ 400 < 600 mm Upper Deviation
Normal	< 0,6	+0,4	+0,5	+0,7	+1,0
	≥ 0,6 < 1,0	+0,5	+0,6	+0,9	+1,2
	≥ 1,0 < 2,0	+0,6	+0,8	+1,1	+1,4
	≥ 2,0 ≤ 3,0	+0,7	+1,0	+1,3	+1,6
Special	< 0,6	+0,2	+0,2	+0,3	+0,5
	≥ 0,6 < 1,0	+0,2	+0,3	+0,4	+0,6
	≥ 1,0 < 2,0	+0,3	+0,4	+0,5	+0,7
	≥ 2,0 ≤ 3,0	+0,4	+0,5	+0,6	+0,8

Table 11: Allowable tolerances in nominal width for slit strip and bars cut from it in accordance with DIN EN 10131 and DIN EN 10143

Nominal length (L)	Allowable excess in nominal length	
	Normal tolerances	Special tolerances (S)
	Upper deviation mm	Upper deviation mm
< 2000	6	3
≥ 2000	0,3 % of the length	0,15 % of the length

Table 12: Allowable tolerances in nominal length for sheet and bars as per DIN EN 10131 and DIN EN 10143

8.3 Length

The values in **Table 12** apply as allowable tolerances for normal and special excess of nominal length. In principle, the actual lengths may not fall short of the nominal length.

8.4 Edge camber

The allowable deviations of edge camber of the longitudinal edges of strip are given in **Table 13.** The largest separation between a longitudinal edge and a straight line connecting both ends of the evaluation length comprises the deviation from edge camber of the longitudinal edge. It is measured on the concave side of the product.

In both cases, inspection shall be carried out at least 5000 mm from the start or end of the strip.

8.5 Out-of-squareness

The deviations from out-of-squareness may not exceed 1 % of the product width in accordance with DIN EN 10131

Product form	Nominal width mm	Allowable deviations of edge camber	
		Max amount mm	For measured length mm
Wide strip	≥ 600	5	2000
Wide strip	≥ 600	0,3 % of the actual length	≤ 2000
Slit strip	< 600	2[1)]	2000

[1)] The special edge camber tolerance (CS) does not apply for high yield strength wide steel strip split lengthwise

Table 13: Allowable tolerances in nominal edge camber for longitudinal edges of sheet as per DIN EN 10131 and DIN EN 10143

and DIN EN 10143. The deviation from out-of-squareness "U" shall be the vertical projection of a transverse edge over a longitudinal edge (see **Fig. 7**).

8.6 Flatness

The deviation from flatness (curvature height) that applies for diagonally cut strip (sheets) shall be the largest distance between the product and a flat, horizontal backing that it sits upon freely. Measurement of the curvature height is only performed along the edges. The allowable normal and special (FS) deviations from flatness follow from **Tables 14 and 15.**

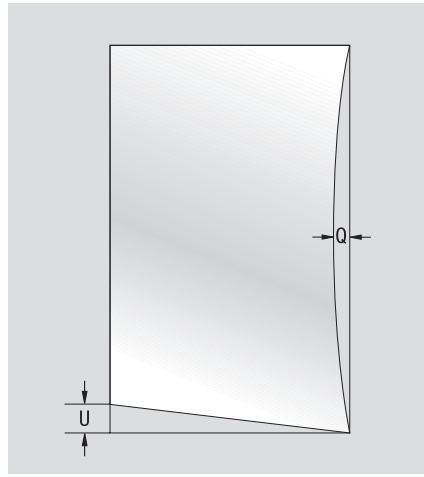


Fig. 7: Deviation from out-of-squareness

Minimum yield strength R_e MPa	Tolerance class	Nominal width w mm	Nominal thickness t		
			t < 0,7 mm	0,7 ≤ t < 1,2 mm	t ≥ 1,2 mm
< 260	Normal	w < 600	7	6	5
		600 ≤ w < 1200	10	8	7
		1200 ≤ w < 1500	12	10	8
		w ≥ 1,500	17	15	13
	Special (FS)	w < 600[1)]	4	3	2
		600 ≤ w < 1200[1)]	5	4	3
		1200 ≤ w < 1500[1)]	6	5	4
		w ≥ 1500[2)]	8	7	6
260 ≤ R_e < 340	Normal	600 ≤ w < 1200	13	10	8
		1200 ≤ w < 1500	15	13	11
		w ≥ 1500	20	19	17
	Special (FS)	600 ≤ w < 1200	8	6	5
		1200 ≤ w < 1500	9	8	6
		w ≥ 1500	12	10	9

[1)] The curvature height for a curvature length of over 200 mm must be less than 1 %.
[2)] The curvature height for a curvature length of over 200 mm must be less than 1,5 %.
For curvature lengths of less than 200 mm, the maximum height of curvature must not exceed 2 mm.

Table 14: Allowable deviations from flatness for cross-sheared cold rolled or electrolytically zinc coated strip (sheets) in accordance with DIN EN 10131

Minimum proof strength $R_{p0,2}$ MPa	Tolerance class	Nominal width w mm	Nominal thickness t		
			t < 0,7 mm	0,7 ≤ t < 1,6 mm	1,6 ≤ t < 3,0 mm
< 260[1)]	Normal	w < 1200 1200 ≤ w < 1500 w ≥ 1500	10 12 17	8 10 15	
	Special (FS)	w < 1200 1200 ≤ w < 1500 w ≥ 1500	5 6 8	4 5 7	3 4 6
260 ≤ $R_{p0,2}$ < 360[2)]	Normal	w < 1200 1200 ≤ w < 1500 w ≥ 1500	13 15 20	10 13 19	
	Special (FS)	w < 1200 1200 ≤ w < 1500 w ≥ 1500	8 9 12	6 8 10	5 6 9

[1)] Applicable also for steel grades with specified minimum yield strength R_e < 260 MPa.
[2)] Applicable also for steel grades DX51D and S550GD.

Table 15: Allowable deviations from flatness for cut to length hot-dip coated strip (sheets) in accordance with DIN EN 10143

For steel grades with higher minimum yield strengths or higher minimum proof strengths, flatness tolerances must be specially agreed.

9 Marking

A tag and label is normally attached to each package or to each coil or unit of shipment with the following information:

- Name or symbol of the steel producer
- Steel grade and metallic coating
- Nominal dimensions of the product
- Identification number
- Weight
- Order number
- Customer name
- Customer order number
- Coating
- Coating thickness
- Colour

Additional symbols can be coordinated with the steel producer. The strips can be designated respectively stamped on request, in which case the designation must be checked against the contents and position.

10 Notes concerning usage and processing

The notes listed in the following for usage and processing should serve as references. Detailed advice from the steel producer is always recommended for each of the usage cases. This ensures that important aspects including protection of sheared edges, selection of suitable combinations of material to avoid galvanic corrosion as well as construction actions for corrosion protection can be noted.

The tooling should be suitably designed for the material, and surfaces should be smooth and clean of course. Polished and hard-chromed tooling is advisable. These minimise abrasion so that damage to the surface can be avoided. In cases where flatness is demanded, such as finishing of uncoated flat product, employment of a suitable straightening machine is recommended.

Processing should take place preferable at temperatures above 20 °C.

In individual cases, formability can be improved by warming the sheet to 25–40 °C using thermal radiation. If pressure marks occur to coated flat product despite care during transport or storage, these changes to the specular gloss can be repaired in many cases by warming the surface up with infrared radiators, for example.

10.1 Forming

Coil coated strip and sheet can be formed by well-known processes such as roll forming (**Fig. 8**), bending, trimming, crimping, rounding, and deep drawing. The following general rules should be considered:

Fig. 8: Roll forming of organic coil coated steel sheet

- Substrates, coating material and coating thickness influence the forming behaviour.
- Thin zinc layers improve the forming results.
- Larger forming radii, low forming speeds (e.g. larger number of stands when roll forming) as well as higher finishing temperatures facilitate forming.
- Forming with thick coatings (PVC plastisol and films) should not take place too close to the cutting surface in order to avoid detachment of the coating due to restoring forces.

In case lubricants are required for deep drawing, these should be selected so that they are compatible with the coating and can be completely removed. Soap-based or wax-based systems have proven themselves. With deep drawing, the following rule of thumb applies for

calculation of the drawing clearances:

- For coating thicknesses of up to 60 µm, 100% of the coating thickness should be taken into account, while over 60 µm, 75% should be taken into account. The thickness of the protective film must be added to the coating thickness.
- Special plastic or rubber cushions have proven themselves as die bolsters.
- Pressure marks or scratches that may occur with steel die bolsters can sometimes be avoided using a protective film on the sheets or on the bolster, as appropriate.

10.2 Cutting

Coil coated flat product can generally be cut, stamped and punched just like non-coated strip and sheet – however, elevated processing speeds should be avoided. Prerequisite for achieving perfect cuts is cleanly polished tools and holding the die clearance to less than 5% of the substrate thickness. Cutting thicker coatings (PVC-Plastisol and films) from the reverse side is recommended.

In processing at the construction site, see to it that drilling or cutting shavings are completely removed, as corrosive shavings can cause damage to the part.

10.3 Joining

Subject to the surface requirements, the properties of the coating and in some cases the forming properties of the substrate are – with limitations for welding – practically all the conventional joining techniques for sheet steel can be employed.

10.3.1 Mechanical joining

For connecting or attaching to coil coated flat products, the well-known joining techniques like screwing, clamping, riveting, folding, crimping, lock forming, and clinching can be employed.

For screw connections, corrosion-free self-threading and self-centering screws with large threads are preferred. Plastic-coated screw heads and plastic washers have proven themselves.

Frequently, the connections can be fabricated by pressing parts into one another using aids such as bolts, pins, clamps and clamping profiles. Moreover, filling hollow spaces by injecting polyurethane, taking into account the material properties of the inner coating (compatibility with adhesives and foam injection) and the visible coating (ability to withstand heat and pressure), is a suitable manufacturing process for fabricating lightweight, efficient construction panels.

The forming properties of the coating (**see Table 2**) must be considered when forming using joining techniques such as folding. In connection with its variations, folding has broad applications, as well as in conjunction with bonding. The cut surfaces of the structural components to be joined can be elegantly covered with calculated arrangement of the folds. Punch riveting for joining coil coated steel sheets is increasing in use. Rivets are available that are pre-coated to match the surface of the materials to be joined using this riveting technique, which works without requiring pre-drilling.

Clinching processes that exclusively utilise forming can also be advantageously used since they cause only minor damage to the coating and avoid corrosion

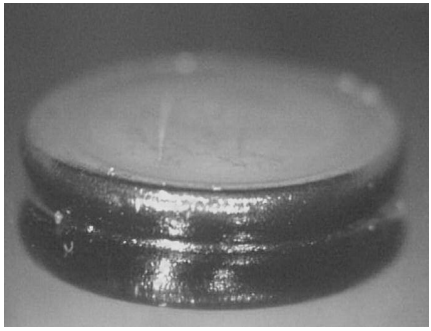


Fig. 9: Clinch connection without damaging the coating

on the cut surfaces, in contrast to clinching that use a cutting process. As with linear folding, the point-oriented joining techniques described can be effectively combined with adhesive techniques (**Fig. 9**).

10.3.2 Bonding

Bonding techniques in conjunction with organic coated sheet steel represent an especially suitable joining technique, either purely with adhesives or in combination with a mechanical joining technique. Force transfers largely uniformly through the extensive connection made by bonding, as long as the bond is fabricated without damaging the organic layer. Furthermore, employing bonding techniques along with the foam injection of hollow spaces mentioned in clause 10.3.1 allows joining of coil coated sheet steel with other suitable materials such as metal, wood, glass and ceramic for example and thereby offer a great deal of freedom in design.

When designing a bonded joint, a structure appropriate for bonding with regard to load and dimension of the bonding surfaces, access for applying the adhesive, and fixating the joint must be considered. The occurrence of peeling forces in the joint area should be largely avoided. Numerous factors must be considered when selecting a suitable adhesive for joining pieces in order to attain an effective and durable bond. The prescribed connection strengths must be reached for example, and/or a specific formability must be guaranteed. The necessary aging and/or weathering durability of the bonded joint must be taken into account. To fulfil these requirements, specialised surface treatment of the parts may also be required prior to bonding. In any case, the influence of various constraints such as humidity and temperature must be considered when bonding. Matching the adhesive to the surface to be bonded is essential for the quality of the bonded joint. A discussion with the steel and adhesive manufacturers is therefore recommended in the initial stage of the design phase.

Further advice on the topic of bonding is contained in Publication 382 entitled “Kleben von Stahl und Edelstahl Rostfrei” (German only) from the Stahl-Informations-Zentrum.

10.3.3 Welding

Coil coated flat product can be welded under certain conditions using resistance projection welding and stud arc welding techniques in conjunction with capacitor discharge (CD), or drawn arc (DA) methods and short cycles. That is only possible however, if a metallic contact is present, i.e. if

- one-side coated sheets are delivered from the manufacturer,
- the coating is removed by the processor in the region of the weld,
- the reverse side exhibits a paint coat with metallic conductive pigments such as zinc dust, aluminium or graphite, or
- the reverse side exhibits such a thin paint layer that this is penetrated locally by the force of the electrodes.

In all cases, only one-side welding processes can be used, and indeed only with extremely short welding times and small electrode pressures in order not to damage the visible side.

In view of the above, short-cycle projection welding utilising capacitor discharge or medium frequency techniques can be advantageously employed.

When designing and selecting materials, sheet thicknesses, surface structure of the plastic coat, and the position and loading performance of the bond must be considered.

Besides these two processes above, with several of the plastic coatings there is a means of joining only the plastic coatings on two sheets using a high-frequency process (dielectric process). This process, similar to bonding, assumes appropriate paint adhesion as well as paint strength in order to achieve the appropriate bonding strengths.

With electrically conductive zinc dust coatings, the welding process used with cold rolled flat product can similarly be employed. In general, higher levels of current and electrode pressures as well as longer welding times are beneficial for perfect welds. In addition, exhausting the welding smoke is recommended.

Welding coil coated flat product with arc welding processes is possible in principle. Due to burn-off of the paint layer in the region of the joint – along with high expenses for refinishing – the process is hardly employed. The same applies for laser beam welding, where the paint burn-off can be kept to a lower level.

Additional advice can be obtained from the manufacturers of the products or taken from Leaflets 2925 and 2927 of the Deutscher Verband für Schweißen und verwandte Verfahren e.V. (DVS).

10.4 Cleaning

Where necessary, the coated surfaces should be cleaned carefully using cold or lukewarm water, where indicated by adding neutral or mild alkaline cleaning agents (ph-values 6–10) and which must be thoroughly rinsed off after use with cold water. Scouring powders, brushes, or dirty sponges must not be used (due to the risk of scratching, adverse effects of the uniform appearance of the surface!). Removal of stubborn contamination should be discussed with the manufacturer of the coil coated flat product.

10.5 Storage period prior to processing

For proper processing of the material, a storage period of six months, beginning with delivery date agreed at the time the order was placed, should not be exceeded. Proper storage of the product is prerequisite.

10.6 Touch up and overcoating

Localised surface defects such as those due to mechanical damage during finishing or assembly can be touched up with suitable air drying paints, where either touch-up brushing or spraying is done depending on the extent. The location to be touched up must be clean and dry.

For extensive overcoating, such as façades, the condition of the substrate and compatibility of the extant coating with the new one to be applied must be checked (see DIN 53221). This applies even when the old coating material is known. The substrate must be free of oil and grease, dry and free of dust, dirt or loose paint layers. High-pressure washing with water and the addition if necessary of a liquid cleaning agent (rinse thoroughly) are appropriate here. Corroded spots which may be present must additionally be cleaned mechanically using a brush or belt sander for example (to remove the corrosion products), and should receive a specialised corrosion protection primer prior to the subsequent area overcoating.

The overcoating system to be used must be suited to the qualitative and aesthetic requirements, the options for application and substrate present. Afterwards, one or two-component systems of different binders can be brushed, rolled, or sprayed on. The details should be set out between the user and the overcoating specialists.

Further information can be taken from Publication 229 entitled “Beschichten von oberflächenveredelten Stahlblech” (“Painting coated steel sheets”) (German only) of the Stahl-Informations-Zentrum.

10.7 Complaints

Since coil coating is a continuous process, there is a possibility that unforeseeable external or internal defects occur in a coil that are extremely difficult to detect or remove. If defects that can substantially spoil appropriate finishing and usage of an order have not been recognized, then the manufacturer tries to locate the causes in the course of processing the complaint and remedy them as far as possible for the subsequent deliveries.

Transmission by the customer of the important data (e.g. coil numbers, defect location), photographs and storage samples if necessary aids the efforts of the steel producer to accelerate the correction process.

11 Notes on the handling of enquiries and orders

In order to be able to match the desired product to the customer's needs in the course of handling enquiries, it is necessary to receive information or specification from the customer that is as detailed as possible. The following points should be noted for example:

- Intended purpose
- Location of use (interior or exterior for roofing or walls)
- Substrate
- Dimensions
- Coating system (if known)
- Coating thickness
- Protective film
- Colour tone
- Specular gloss
- Processing conditions
- Environmental conditions under usage
- Customer specifications, especially requirements for top or reverse side
- Additional information about the structural component: Specimens, photographs, drawings

If detailed information cannot be furnished by the customer, the steel producers will offer the most suitable product based on their own experience. The provisional data presented during the enquiry process mentioned above must be finalised and also confirmed at the time of order.

Delivery takes place in accordance with the characteristic properties set down in this document for organic coil coated steel flat products. It is therefore in the interests of the parties to refer to the the Stahl-Informations-Zentrum document at time of order through the order addendum "nach Stahl-Informations-Zentrum" (in accordance with the Stahl-Informations-Zentrum) and/or according to the delivery provisions (specifications) of the customer.

12 Packing, storage and transport

To protect against damage, contamination, or moisture as well as to secure the material during storage and transport, various kinds of packing is used for strip and sheet deliveries. These are matched to the requirements of the customer and summarised in the guidelines of the steel producer for packing, storage, and transport of non-coated and coated sheet steel in sheets, rolls, and split strip.

Publication 114 entitled "Verpackung, Lagerung und Transport von unbeschichtetem und beschichtetem Band und Blech" ("Packing, storage, and transport of non-coated and coated strip and sheet") (German only) from the Stahl-Informations-Zentrum contains important guidance on this topic.

13 Classification of colours of liquid coatings for exterior use

Coil coated sheet steel can be delivered in numerous colours and textures. Film coatings are represented in a more limited spectrum. Liquid coatings, which rank considerably ahead of film coatings with respect to their usage, can be pre-

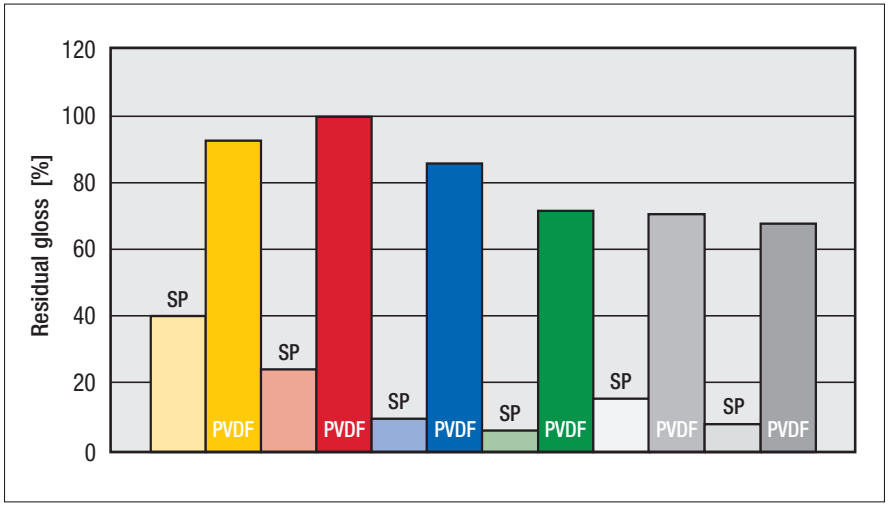


Fig. 10: Comparison of polyester to PVDF: gloss stability after 5 years of natural weathering in Florida

pared in almost any colour. Exceptions occur due to the necessary use of high-quality, temperature-stable coloured pigments. Proprietary colours of the customer, as well as standardised ones can be prepared. Colours based on RAL, DIN and NCS are part of the latter group. The RAL colours are clearly more popular than colours from other systems.

Table 16 below gives a quick overview of the well and very well reproducable RAL colours. The Table is meant to be informative in nature. There can be limitations in individual cases depending on the binder system. The RAL colours not mentioned cannot be acceptably reproduced. There are colour matches in these cases, however, that come close to the character of the respective RAL colour.

Discussions with the supplier with respect to achieving the desired RAL colour tone are recommended primarily for intense yellow or orange colour tones. As a result of statutory regulations regarding workplace and environmental protection, these colour tones as shown in **Table 16** cannot be reproduced as exactly in future on account of changeovers in the pigmentation.

Fig. 10 is exemplary of weathering durability for coloured polyester and PVDF coatings under extreme weathering (Florida test) as for example the changes to gloss. The coloured shading symbolizes the proven colour tone of the coatings.

RAL-Group	840 HR/RAL		SP				PVDF			
			ΔE < 1	ΔE 1–2	ΔE 2–5	ΔE > 5	ΔE < 1	ΔE 1–2	ΔE 2–5	ΔE > 5
RAL 1000	1000	Green beige	x				x			
	1001	Beige	x				x			
	1002	Sand yellow	x				x			
	1003	Signal yellow		x					x	
	1004	Golden yellow	x						x	
	1005	Honey yellow		x					x	
	1006	Maize yellow		x					x	
	1007	Daffodil yellow		x					x	
	1011	Brown beige		x				x		
	1012	Lemon yellow	x						x	
	1013	Oyster white	x				x			
	1014	Ivory	x				x			
	1015	Light ivory	x				x			
	1016	Sulfur yellow			x				x	
	1017	Saffron yellow			x				x	
	1018	Zinc yellow		x					x	
	1019	Grey beige		x				x		
	1020	Olive yellow	x				x			
	1021	Rape yellow		x					x	
	1023	Traffic yellow		x					x	
	1024	Ochre yellow	x					x		
	1026	Luminous yellow				x				x
	1027	Curry		x				x		
	1028	Melon yellow			x					x
	1032	Broom yellow	x				x			
	1033	Dahlia yellow		x					x	
	1034	Pastel yellow		x				x		
RAL 2000	2000	Yellow orange			x				x	
	2001	Red orange			x				x	
	2002	Vermilion			x				x	

Table 16: Colour Matching according to RAL-colour chart 840 HR
(ΔE-variance RAL/Coil-Coating)

RAL-Group	840 HR/RAL		SP				PVDF			
			ΔE < 1	ΔE 1–2	ΔE 2–5	ΔE > 5	ΔE < 1	ΔE 1–2	ΔE 2–5	ΔE > 5
	2003	Pastel orange			x					x
	2004	Pure orange			x					x
	2005	Luminous orange				x				x
	2007	Luminous bright orange				x				x
	2008	Bright red orange			x					x
	2009	Traffic orange			x					x
	2010	Signal orange		x					x	
	2011	Deep orange		x					x	
	2012	Salmon orange		x				x		
RAL 3000	3000	Flame red		x				x		
	3001	Signal red			x				x	
	3002	Carmine red			x				x	
	3003	Ruby red		x					x	
	3004	Purple red	x							x
	3005	Wine red		x					x	
	3007	Black red		x				x		
	3009	Oxide red		x				x		
	3011	Brown red		x					x	
	3012	Beige red		x				x		
	3013	Tomato red		x					x	
	3014	Antique red		x				x		
	3015	Light pink	x				x			
	3016	Coral red		x					x	
	3017	Rose		x					x	
	3018	Strawberry red			x				x	
	3020	Traffic red		x					x	
	3022	Salmon pink	x				x			
	3024	Luminous red				x				x
	3026	Luminous bright red				x				x
	3027	Raspberry red			x					x

RAL-Group	840 HR/RAL		SP				PVDF			
			ΔE < 1	ΔE 1–2	ΔE 2–5	ΔE > 5	ΔE < 1	ΔE 1–2	ΔE 2–5	ΔE > 5
	3031	Orient red		x					x	
RAL 4000	4001	Red lilac		x					x	
	4002	Red violet			x				x	
	4003	Heather violet		x				x		
	4004	Claret violet			x					x
	4005	Blue lilac			x				x	
	4006	Traffic purple			x					x
	4007	Purple violet			x					x
	4008	Signal violet			x				x	
	4009	Pastel violet	x					x		
	4010	Telemagenta			x				x	
RAL 5000	5000	Violet blue		x					x	
	5001	Green blue		x					x	
	5002	Ultramarine blue		x						x
	5003	Sapphire blue	x						x	
	5004	Black blue	x						x	
	5005	Signal blue		x					x	
	5007	Brilliant blue		x				x		
	5008	Grey blue		x				x		
	5009	Azure blue		x				x		
	5010	Gentian blue			x				x	
	5011	Steel blue	x				x			
	5012	Light blue	x					x		
	5013	Cobalt blue	x						x	
	5014	Pigeon blue	x					x		
	5015	Sky blue	x				x			
	5017	Traffic blue		x					x	
	5018	Turquoise blue		x				x		
	5019	Capri blue		x					x	

Table 16, continued: Colour Matching according to RAL-colour chart 840 HR
(ΔE-variance RAL/Coil-Coating)

RAL-Group	840 HR/RAL		SP				PVDF			
			ΔE < 1	ΔE 1–2	ΔE 2–5	ΔE > 5	ΔE < 1	ΔE 1–2	ΔE 2–5	ΔE > 5
	5020	Ocean blue			x					x
	5021	Water blue		x				x		
	5022	Night blue			x					x
	5023	Distant blue		x				x		
	5024	Pastel blue	x					x		
RAL 6000	6000	Patina green		x				x		
	6001	Emerald green		x				x		
	6002	Leaf green		x				x		
	6003	Olive green		x				x		
	6004	Blue green	x						x	
	6005	Moss green	x						x	
	6006	Grey olive	x						x	
	6007	Bottle green		x					x	
	6008	Brown green		x					x	
	6009	Fir green		x						x
	6010	Grass green	x						x	
	6011	Reseda green	x				x			
	6012	Black green		x					x	
	6013	Reed green	x				x			
	6014	Yellow olive		x				x		
	6015	Black olive		x					x	
	6016	Turquoise green		x					x	
	6017	May green	x				x			
	6018	Yellow green		x					x	
	6019	Pastel green	x				x			
	6020	Chrome green	x						x	
	6021	Pale green	x				x			
	6022	Olive drab		x					x	
	6024	Traffic green	x						x	
	6025	Fern green		x				x		

RAL-Group	840 HR/RAL		SP				PVDF			
			ΔE < 1	ΔE 1–2	ΔE 2–5	ΔE > 5	ΔE < 1	ΔE 1–2	ΔE 2–5	ΔE > 5
	6026	Opal green		x						x
	6027	Light green	x				x			
	6028	Pine green		x					x	
	6029	Mint green	x							x
	6032	Signal green		x				x		
	6033	Mint turquoise	x					x		
	6034	Paste turquoise	x				x			
RAL 7000	7000	Squirrel grey	x				x			
	7001	Silver grey	x				x			
	7002	Olive grey	x				x			
	7003	Moss grey	x				x			
	7004	Signal grey	x				x			
	7005	Mouse grey	x				x			
	7006	Beige grey		x				x		
	7008	Khaki grey		x				x		
	7009	Green grey		x				x		
	7010	Tarpaulin grey		x				x		
	7011	Iron grey		x				x		
	7012	Basalt grey	x					x		
	7013	Brown grey		x				x		
	7015	Slate grey	x					x		
	7016	Anthracite grey		x					x	
	7021	Black grey	x						x	
	7022	Umbra grey	x				x			
	7023	Concrete grey	x				x			
	7024	Graphite grey		x				x		
	7026	Granite grey	x					x		
	7030	Stone grey	x				x			
	7031	Blue grey		x				x		

Table 16, continued: Colour Matching according to RAL-colour chart 840 HR
(ΔE-variance RAL/Coil-Coating)

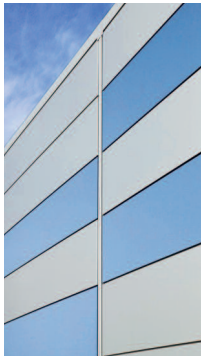
RAL-Group	840 HR/RAL		SP				PVDF			
			ΔE < 1	ΔE 1–2	ΔE 2–5	ΔE > 5	ΔE < 1	ΔE 1–2	ΔE 2–5	ΔE > 5
	7032	Pebble grey	x				x			
	7033	Cement grey	x				x			
	7034	Yellow grey	x				x			
	7035	Light grey	x				x			
	7036	Platinum grey	x				x			
	7037	Dusty grey	x				x			
	7038	Agate grey	x				x			
	7039	Quartz grey	x				x			
	7040	Window grey	x				x			
	7042	Traffic grey A	x				x			
	7043	Traffic grey B	x					x		
	7044	Silk grey	x				x			
	7045	Telegrey 1	x				x			
	7047	Telegrey 4	x				x			
RAL 8000	8000	Green brown		x				x		
	8001	Ochre brown		x				x		
	8002	Signal brown		x				x		
	8003	Clay brown		x					x	
	8004	Copper brown		x				x		
	8007	Fawn brown	x					x		
	8008	Olive brown		x				x		
	8011	Nut brown		x				x		
	8012	Red brown	x				x			
	8014	Sepia brown		x				x		
	8015	Chestnut brown		x				x		
	8016	Mahogany brown		x				x		
	8017	Chocolate brown	x					x		
	8019	Grey brown		x				x		
	8022	Black brown		x					x	
	8023	Orange brown		x					x	

RAL Group	840 HR/RAL		SP				PVDF			
			ΔE < 1	ΔE 1–2	ΔE 2–5	ΔE > 5	ΔE < 1	ΔE 1–2	ΔE 2–5	ΔE > 5
	8024	Beige brown	x					x		
	8025	Pale brown		x				x		
	8028	Terra brown		x				x		
RAL 9000	9001	Cream	x					x		
	9002	Grey white	x				x			
	9003	Signal white		x					x	
	9004[1)]	Signal black								
	9005[1)]	Jet black								
	9006[2)]	White aluminium								
	9007[2)]	Grey aluminium								
	9010	Pure white			x				x	
	9011[1)]	Graphite black								
	9016	Traffic white		x					x	
	9017[1)]	Traffic black								
	9018	Papyrus white	x					x		

[1)] Visual comparison recommended

[2)] Instrumental comparison not feasible

Table 16, continued: Colour Matching according to RAL-colour chart 840 HR
(ΔE-variance RAL/Coil-Coating)



Building envelopes of an industrial complex in the Ruhr area (far left) and coloured wall components on an industrial building (left)

School roof of continuously organic coated (coil coated) sheet steel in Fort Alexander, Manitoba, Canada

Commercial building with energy-efficient façade

14 Standards

14.1 Materials

14.1.1 Organic coated (coil coated) steel flat products

DIN EN 10169:2011
Continuously organic coated (coil coated) steel flat products – Technical delivery conditions

14.1.2 Cold rolled steel flat products

DIN 1623:2009
Cold rolled strip and sheet – Technical delivery conditions – General structural steels

DIN EN 10130:2007
Cold rolled low carbon steel flat products for cold forming – Technical delivery conditions
- Thicknesses from 0,35 to 3 mm
- Grades (table) as non-alloy respectively alloy quality steel DC01 drawing quality, DC03 deep drawing quality, DC04 and DC05 special deep drawing quality, DC06 extra deep drawing quality, DC07 super deep drawing quality

DIN EN 10131:2006
Cold rolled uncoated and zinc or zinc-nickel electrolytically coated low carbon and high yield strength steel flat products for cold forming – Tolerances on dimensions and shape
- Tolerances of thickness
- Tolerances of width for sheet, wide strip and slit wide strip of width less than 600 mm
- Tolerances of length
- Tolerances of flatness
- Tolerance of out-of-squareness
- Tolerances of edge camber
- Superimposition of dimensions

DIN EN 10139:1997
Cold rolled uncoated mild steel narrow steel strip for cold forming – Technical delivery conditions
- Grades of non-alloyed and alloyed steels in rolling-width less than 600 mm

DIN EN 10140:2006
Cold rolled narrow steel strip – Tolerances on dimensions and shape
- Tolerances of thickness, width respectively length
- Edge camber
- Flatness of cold rolled narrow steel strip in bars
- Out-of-Squareness

DIN EN 10268:2006
Cold rolled steel flat products with high yield strength for cold forming – Technical delivery conditions
- Bake-Hardening Steels (B), Rephosphorized Steels (P), Low Alloy/Micro-alloyed Steels (LA), Interstitial free Steels (Y), Isotropic Steels (I);
- 19 grades (table 1: chemical composition, table 2: mechanical properties)

14.1.3 Further cold rolled steel flat products

DIN EN 10106:2007
Cold rolled non-oriented electrical steel sheet and strip delivered in the fully processed state

DIN EN 10107:2005
Grain-oriented electrical steel sheet and strip delivered in the fully processed state

DIN EN 10205:1992
Cold reduced blackplate in coil form for the production of tinplate or electrolytic chromium/chromium oxide coated steel

DIN EN 10341:2006
Cold rolled electrical non-alloy and alloy steel sheet and strip delivered in the semi-processed state

DIN EN 10342:2005
Magnetic materials – Classification of surface insulations of electrical steel sheet, strip and laminations

14.1.4 Metallic coated flat products

DIN EN 10143:2006
Continuously hot-dip coated steel sheet and strip – Tolerances on dimensions and shape
- zinc coatings (Z), zinc-iron alloy coatings (ZF), zinc-aluminium coatings (ZA), aluminium-zinc coatings (AZ), aluminium-silicon coatings (AS) of low carbon and high proof steels for cold forming as well as of structural steels
- Thicknesses from 0,20 to 6,50 mm
- Tolerances of thickness, width and length
- Superimposition of dimensions of out-of-squareness and edge camber

DIN EN 10152:2009
Electrolytically zinc coated cold rolled steel flat products for cold forming – Technical delivery condition
- Of low carbon steel for cold forming in rolled width > 600 mm, also applicable for colled rolled narrow steel strip, for steel with high yield strength and improved formability (colled rolled), mulitiphase steel (colled and hot rolled) as well as for structural steel
- Nominal zinc coating (table 2)

DIN EN 10346:2009
Continuously hot-dip coated steel flat products – Technical delivery conditions
- Low carbon steel for cold forming, steel for use in construction (structural steel), steel with high proof strength for cold forming with coatings of zinc (Z), of zinc-iron alloy (ZF), of zinc-aluminium (ZA), of aluminium-zinc (AZ), of aluminium-silicon (AS) as well as multiphase steel for cold forming with coatings of zinc (Z), of zinc-iron alloy (ZF) and of zinc-aluminium (ZA)
- Coating weights (table 11)

SEW 022 (Stahlinstitut VDEh):2010
Continuously hot-dip coated steel flat products – Zinc-magnesium coatings
Technical delivery conditions

14.1.5 Further metallic coated flat products

DIN EN 10202:2001
Cold reduced tinmill products – Electrolytic tinplate and electrolytic chromium/chromium oxide coated steel;
- simple cold-rolled or double-reduced low carbon steel in thicknesses from 0,17 to 0,49 mm respectively from 0,13 to 0,29 mm in width > 600 mm
- Terms and definitions, coatings, mechanical properties, tolerances on dimensions and shape

14.1.6 Stainless Steels

DIN EN 10088-1:2005
Stainless steels – Part 1: List of stainless steels

DIN EN 10088-2:2005
Stainless steels – Part 2: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for general purposes

DIN EN 10088-4:2010
Stainless steels – Part 4: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for construction purposes

14.2 Test methods

14.2.1 DIN EN 13523: Coil coated metals – Test methods

DIN EN 13523-0:2001
Part 0: General introduction and list of test methods
- Terms:
  coatings in categories 1 or 2, coat, coating substance, coil coating, organic coatings, paint/varnish, underground/substrate

DIN EN 13523-1:2010
Part 1: Film thickness
- Terms:
  coating thickness, measurement surface
- Principle of measurement:
  magnetic induction (steel), eddy currents (aluminium), micrometer gauge, optical means

DIN EN 13523-2:2001
Part 2: Specular gloss
- Terms:
  gloss, reflectometer value
- Principle of measurement:
  reflectometer measurement (60° angle, but 20° and 85° can be used for more accurate measurement of high or low values)

DIN EN 13523-3:2001
Part 3: Colour difference – Instrumental comparison
- Terms:
  colour, embossed coating, metamerism, textured coating
- Principle of measurement:
  conformity to colour standard using tristimulus colorimeter or recording spectrophotometer; CIELAB colour deviation

DIN EN 13523-4:2001
Part 4: Pencil hardness
- Test method:
  scratching with pencils of different hardnesses

DIN EN 13523-5:2001
Part 5: Resistance to rapid deformation (impact test)
- Test method:
  an apparatus in accordance with EN ISO 6272 (impact test), evaluation of cracking (under magnification), respectively adhesion (using adhesive tape)

DIN EN 13523-6:2002
Part 6: Adhesion after indentation (cupping test)
- Test method:
  Cross-cut test in combination with a cupping test; evaluation of adhesion respectively crack formation

DIN EN 13523-7:2001
Part 7: Resistance to cracking on bending (T-bend test)
- Terms:
  metal thickness
- Test method:
  cylindrical or conical fold (bend) from 135° through 180° (T-Bend = minimum bending radius for given metal thickness), evaluation under magnification and using adhesive tape

DIN EN 13523-8:2010
Part 8: Resistance to salt spray (fog)
- Test method:
  two kinds of samples (with scratches and if applicable hole; conical bend), neutral-pH respectively acetic acid salt spray fog, agreed period of time, evaluation of blistering and/or corrosion creep (subsurface migration)

DIN EN 13523-9:2001
Part 9: Resistance to water immersion
- Test method:
  immersion of the scratched test specimens in 40 °C warm water, evaluate for blistering and corrosion creep (using adhesive tape, depending on category of coating)

DIN EN 13523-10:2010
Part 10: Resistance to fluorescent UV light and water condensation
- Test method:
  cyclic corrosion test with UV/dry respectively without UV/condensation of water, evaluation for chalking and changes to gloss and colour

DIN EN 13523-11:2011
Part 11: Resistance to solvents (rubbing test)
- Test method:
  rubbing with absorbent material soaked in a solution of methyl ethyl ketone (MEK)

DIN EN 13523-12:2005
Part 12: Resistance to scratching
- Test method:
  scratching with a moving needle, load to be agreed

DIN EN 13523-13:2001
Part 13: Resistance to accelerated ageing by the use of heat
- Test method:
  flat samples or ones with various bends stored in a heated cabinet (temperature and duration as agreed), determination of crack formation and adhesion (with flat samples subsequently bent) using adhesive tape

DIN EN 13523-14:2001
Part 14: Chalking (Helmen method)
- Terms:
  chalking
- Test method:
  evaluate by peeling off (transparent) adhesive tape and glossmeter

DIN EN 13523-15:2002
Part 15: Metamerism
- Terms:
  metamerism, metamerism index
- Measurement principle:
  spectrophotometric determination of colour deviation for various types of light

DIN EN 13523-16:2005
Part 16: Resistance to abrasion
- Test method:
  determination of the loss of mass from a sample following abrasion stress (abrasive wheels and duration as agreed) in a Taber abrasion tester (or comparable device)

DIN EN 13523-17:2011
Part 17: Adhesion of strippable films
- Terms:
  strippable film
- Test method:
  determination of the force necessary to peel of a film under defined conditions from the surface of a coil coated material using a dynamometer or a spring balance

DIN EN 13523-18:2002
Part 18: Resistance to staining
- Test method:
  apply the substance to the sample (either open or covered) or immerse the sample. Duration as agreed. Evaluation for colouration, blistering, softening, etc.

DIN EN 13523-19:2011
Part 19: Panel design and method of atmospheric exposure testing
- Test method:
  ECCA weathering and sample orientation fixture in different directions (45° to the horizontal, southern exposure; 90° to the horizontal, northern exposure; 5° to the horizontal, overlapping, southern exposure). Samples with scratches and conical bends. Duration as agreed. Monitoring of parameters (depending on microclimate) that can have an influence on the weathering results. Monitoring of ECCA weathering sites

DIN EN 13523-20:2012
Part 20: Foam adhesion
- Terms:
  foam
- Test method:
  foam applied to samples tested with respect to adhesion in dry and wet conditions

DIN EN 13523-21:2010
Part 21: Evaluation of outdoor exposed panels
- Test method:
  inspection of samples positioned per Part 19 (for each exposure angle) for gloss and colour changes, chalking, crack formation at the bend, damage at the shear line, surface, along the scratch, etc.; inspection record

DIN EN 13523-22:2010
Part 22: Colour difference – Visual comparison
- Terms:
  colour, metamerism
- Test method:
  lighting conditions (natural or artificial daylight, colour-matching booth), influence of the observer

DIN EN 13523-23:2002
Part 23: Colour stability in humid atmospheres containing sulphur dioxide
- Test method:
  subject samples to cycle of humidity and SO_2/dry conditions in test chamber (5 cycles: 8+16 hours)

DIN EN 13523-24:2005
Part 24: Resistance to blocking and pressure marking
- Test method:
  expose stacked samples to pressure and heat. Qualitative evaluation for blocking/sticking and changes to gloss or pressure marks

prEN 13523-25:2006
Part 25: Resistance to humidity
- Test method:
  continuous inspection with defined specifications at elevated temperature or cyclic check of moisture/dryness at room temperature or moisture at elevated and depressed temperature (humidity cabinet), scratches or bending of samples as appropriate
- Determination blistering and corrosion

DIN EN 13523-26:2006
Part 26: Resistance to condensation of water
- Test method:
  Continuous inspection at elevated temperature (chamber in accordance with EN ISO 6270-1). Test duration as agreed
- Determination of blistering and visual changes as appropriate

DIN EN 13523-27:2009
Part 27: Resistance to humid poultice (Cataplasm test)

DIN EN 13523-29:2010
Part 29: Resistance to environmental soiling (Dirt pick-up and striping)

Further test methods in preparation

Note:
CD-Rom European Standards "Finish first – Fabricate later" (Coil coated metals: products, test methods – no drafts), trilingual (D, E, F), Beuth Verlag, Berlin, with ECCA, DIN, AFNOR

14.2.2 Further test regulations

DIN 6172:1993
Special metamerism-index for pairs of samples at change in illuminant

DIN EN ISO 2409:2007
Paints and varnishes – Cross-cut test

DIN EN ISO 2808:2007
Paints and varnishes - Determination of film thickness
- Test method:
  additional methods not included in DIN EN 13523-1

DIN EN ISO 2815:2003
Paints and varnishes – Buchholz indentation test
- Test method:
  apparatus for indentation (with pressure) and indenter (sharp-edges metal wheel); measurement of indentation length with a microscope; result as resistance to indentation (reciprocal indentation length)

DIN EN ISO 6270-1:2002
Paints and varnishes – Determination of resistance to humidity – Part 1: Continuous condensation

DIN EN ISO 11997-1:2006
Paints and varnishes – Determination of resistance to cyclic corrosion conditions –
Part 1: Wet (salt fog)/dry/humidity
- Test method:
  four harmonised cycles

DIN EN ISO 12944-2, 1998
Paints and varnishes – Corrosion protection of steel structures by protective paint systems, Part 2: Classification of environments

ISO 7724:1984
Paints and varnishes; Colorimetry
Part 1: Principles
Part 2: Colour measurement
Part 3: Calculation of colour differences

ASTM D 4214-2007
Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films
- Test method:
  Wiping with a soft cloth and comparison with a photografic standard (ASTM marking from 8 downwards to 0 = poor and TNO-marking reciprocal from 2 upwards to 10 = poor, respectively); reflectometer measurement using adhesive tape

ASTM D 4145-2010
Standard Test Method for Coating Flexibility of Prepainted Sheet

14.2.3 Stahl-Eisen-Prüfblatt (SEP) 1160 of the Steel-Institute VDEh

SEP 1160 – Evaluation of weldable corrosion protection primers for the automotive industry
Part 1, 2004: Corrosion performance
Part 2, 2004: Measurement of coating weight by gravimetric analysis

Part 3, 2005: Adhesion behavior
Part 4, 2005: Peel-off behavior
Part 5, 2005: Adhesive bonding properties
Part 6, 2005: Suitability for electrodeposition painting
Part 7, 2008: Procedure for quantitative determination of welding fumes from resistance spot welding

14.3 Standards for structural components

DIN 18516-1:2010
Cladding for external walls, ventilated at rear – Part 1: Requirements, principles of testing

DIN 55634:2010
Paints, varnishes and coatings – Corrosion protection of supporting thin-walled building components made of steel

DIN 59231:2003
Corrugated sheets and roofing sheets, surface coated – Dimensions, masses and static values

DIN EN 505:1999
Roofing products from metal sheet – Specification for fully supported roofing products of steel sheet

DIN EN 508-1:2009
Roofing products from metal sheet – Specification for self-supporting products of steel, aluminium or stainless steel sheet – Part 1: Steel

DIN EN 508-3:2009
Roofing products from metal sheet – Specification for self-supporting products of steel, aluminium or stainless steel sheet – Part 3: Stainless steel

DIN EN 10162:2003
Cold-rolled steel sections - Technical delivery conditions – Dimensional and cross-sectional tolerances

DIN EN 14509:2007
Self-supporting double skin metal faced insulating panels – Factory made products – Specifications

DIN EN 14782:2006
Self-supporting metal sheet for roofing, external cladding and internal lining – Product specification and requirements

DIN EN 14783:2006
Fully supported metal sheet and strip for roofing, external cladding and internal lining – Product specification and requirements

14.4 Management systems

DIN EN ISO 14001:2009
Environmental management systems – Requirements with guidance for use

DIN EN ISO 9000ff:2005
Quality management systems

15 Additional regulations and technical literature

Meuthen, Bernd; Jandel, Almuth-Sigrun:
Coil-Coating/Bandbeschichtung – Verfahren, Produkte und Märkte
JOT-Fachbuch, 2. akt. und erw. Auflage
Vieweg Verlag/GWV Fachverlage GmbH, Wiesbaden, 2008

Publications from the Stahl-Informations-Zentrum (www.stahl-info.de)

Charakteristische Merkmale 090
Schwingungsdämpfendes Verbundband und Verbundblech

Charakteristische Merkmale 092
Elektrolytisch verzinktes Band und Blech

Characteristic Properties 095 – E
Continuous Hot-Dip Coated Steel Strip and Sheet

Dokumentation 545
Dachpfannen aus Stahl –
intelligente Lösungen für jedes Dach

Dokumentation 558
Bausysteme aus Stahl für Dach und Fassade

Dokumentation 568
Leichtbausysteme aus Stahl für Dach und Fassade – Energie- und kosteneffiziente Lösungen für Neu- und Bestandsbau

Dokumentation 588
Dach- und Fassadenelemente aus Stahl – Erfolgreich Planen und Konstruieren

Merkblatt 109
Stahlsorten für oberflächenveredeltes Feinblech

Merkblatt 110
Schnittflächenschutz und kathodische Schutzwirkung von schmelztauchveredeltem und bandbeschichtetem Feinblech

Merkblatt 114
Verpackung, Lagerung und Transport von unbeschichtetem und beschichtetem Band und Blech

Merkblatt 121
Korrosionsschutzsysteme für Bauelemente aus Stahlblech

Publication 122 – E
Weldable Corrosion-Protection Primer – Thin Film-Coated Steel Sheets for the Automotive Industry

Merkblatt 229
Beschichten von oberflächenveredeltem Stahlblech

Merkblatt 382
Kleben von Stahl und Edelstahl Rostfrei

Lieferverzeichnis
Oberflächenveredeltes Feinblech

Publication from the FOSTA – Forschungsvereinigung Stahlanwendung e. V. (www.stahlforschung.de)

Dokumentation 707
Fügen durch Umformen, Nieten und Durchsetzfügen – Innovative Verbindungsverfahren für die Praxis

Publication from the IFBS – Industrieverband für Bausysteme im Metallleichtbau e.V. (www.ifbs.de)

Multitude of Publications concerning Lightweight Construction with Steel for Roofs and Facades

Publications from the DVS – Deutscher Verband für Schweißen und verwandte Verfahren e.V. (www.dvs-ev.de)

Merkblatt 2925, Ausgabe 2005
Widerstandspunkt-, Buckel- und Rollennahtschweißen von organisch dünnfilmbeschichteten Stahlfeinblechen

Merkblatt 2927, Ausgabe 2010
Widerstandsbuckel- und Lichtbogenbolzenschweißen von einseitig dick kunststoffbeschichteten Stahlfeinblechen

Merkblatt 2939, Ausgabe 2006
Widerstandspunkt-, Buckel- und Rollennahtschweißen von Stahl-Kunststoff-Stahl-Verbundwerkstoffen

Note:
The publications of the above mentioned organisations are mostly available by internet and directly downloadable.

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