wieland

Strip for connectors

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Requirements to the copper base material

Copper and Copper alloys for a wide variety of connectors

Connection technology for electronic components has to fulfill various tasks using a high variety of different connectors, such as miniaturized spring-type terminals, press-fit connectors, high current connectors. All these connectors are preferably made of copper and copper alloys. Very often strip is used. Due to the different jobs to be done, the requirements on the base materials differ from case to case.

On one hand the production of a connector has requirements to further processibility, e.g. heavy cold forming in flexible press-in zones of a press-fit connector. On the other hand, mechanical and electrical task-related functional requirements over the entire service life, are designed in by the design engineers and expected to be supplied by the base material.

Requirements to processibility

Copper and copper alloy strip is subjected to various processes which the customers apply. Usually stamping is the first step. Stamping takes place in combination with cold forming operations such as bending, embossing and deep drawing. Further steps might be welding and galvanic coating. The material's contribution to these processes are:

– ductility and forming capacity
– weldability
– coatability

The ability to be coated by galvanic process with tin, silver, nickel and copper layers is given by all copper alloys. Additionally Wieland is able to offer pre-tinned strip by the hot-dip tin coating process. The properties, advantages of hot-dip tin coated strips and its variants are described in a separate brochure.

*Fig. 1:
Press-fit connectors*

Functional requirements

After the material has been converted into a connector, it has to meet certain functional requirements depending on the specific tasks of the connector. The requirements are translated into material properties in the following way:

- conducting high currents and transfering high signal rates without self-heating requires high electrical conductivity
- applying high spring forces relates to high strength
- keeping the properties constant over long period and at elevated service temperature relates to resistance against thermal stress relaxation

As some properties cannot be optimized at the same time in one alloy, e.g. conductivity and strength, prioritizing is necessary. High-conductivity is required, if the task of the connector is to transfer high currents and avoid self-heating. In other cases, high spring forces are the prioritized requirement, the material must have high strength.

Wieland Copper materials for connectors

Selecting the suitable copper alloy

For the selection of materials, a wide variety of alloys with different properties is available. Fig. 2 shows the Wieland alloys in the conductivity – strength diagram. This diagram shows the Wieland copper alloys in tempers which all exhibit the same cold formability (bendable 90°GW, r/t = 0.5). The diagram allows easy alloy selection according to the properties electrical conductivity and strength.
The copper alloys with high-thermal relaxation resistance are indicated in red in Fig. 2.

Pure Coppers

Pure copper is characterized by the highest achievable electrical conductivity of 58 MS/m (100 % IACS). Pure copper is the first choice in applications, where the focus is on conducting of high currents and/or heat.

Typical applications include cables, bus bars, solderless terminals and substrates for power electronics.

High-copper alloys incl. copper iron alloys

In cases of higher strength and high conductivity requirements, the material group of high-copper alloys is used. These alloys contain small amounts of solid solution hardening atoms such as tin and zinc.

Examples are Wieland-K81 (CuSn0.15, C14415) as well as the copper-iron alloys Wieland-K80 (CuFe0.1P, C19210) and Wieland-K65 (CuFe2P, C19400)

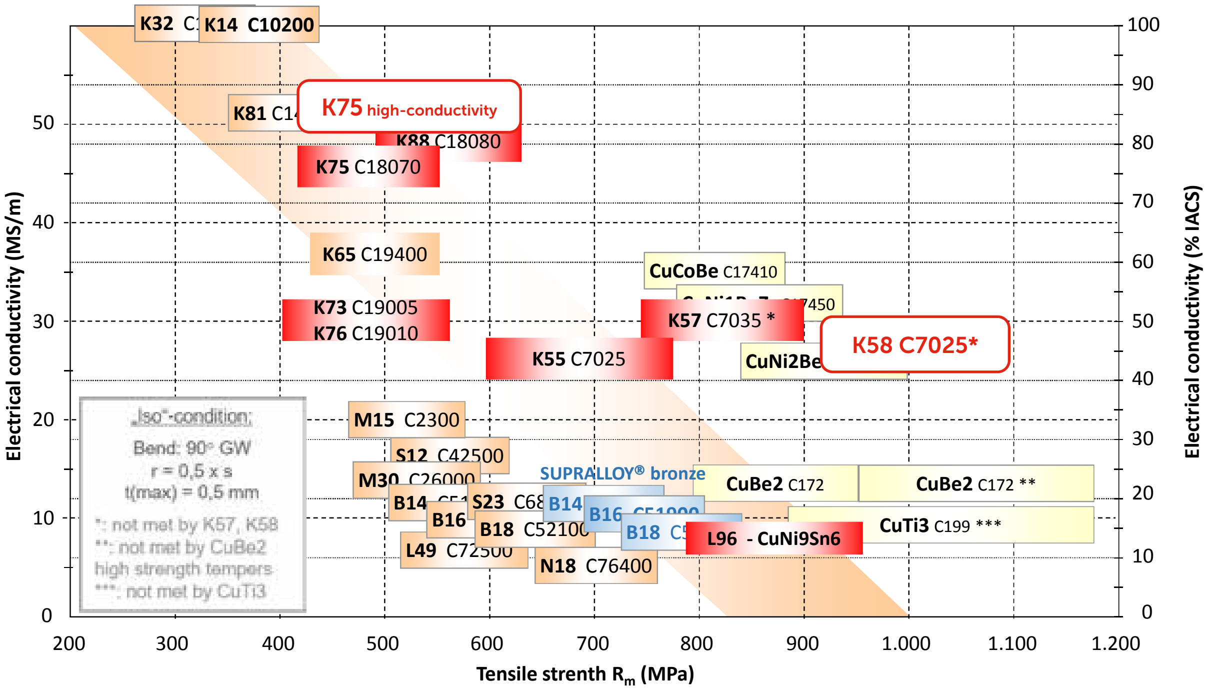

Fig. 2:
Conductivity-strength diagram showing the property combination of various alloys. The group of high-performance alloys, which show a very good thermal-relaxation resistance are highlighted in red color. Fine grain bronzes (SUPRALLOY® bronzes) are indicated in blue.

A detailed material selection program is available in the internet under www.wieland-alloywizard.com as well as on the Wieland website.

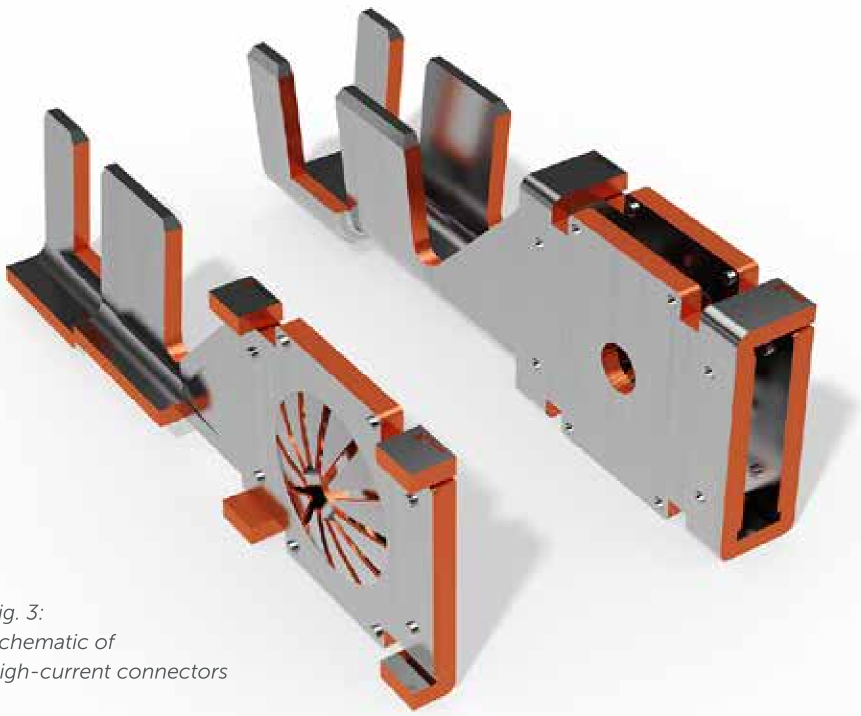

Fig. 3:
Schematic of high-current connectors

High-performance copper alloys

High-performance copper alloys combine a certain electrical conductivity and strength with a high thermal relaxation resistance. The latter property describes the ability of the material, to keep the spring forces in a connector as high as possible, at elevated temperatures over long periods of time. The ability is based on the metallurgical phenomenon called precipitation hardening. Therefore, certain elements are added, such as Ni + Si, Cr + Si and Si + Ti.

These alloys are well established in many kinds of applications, such as spring connectors, press-fit connectors, contact springs in terminal blocks, relays, switches, miniaturized connectors, e.g. board-to-board connectors, as well as in sockets for microprocessors.

Typical alloys are:

– High-Strength type alloys
K55 (CuNi3SiMg, C70250)
K57 (CuNi1Co1Si, C70350)
K73 (CuNi1ZnSi, C19005)
K76 (CuNi1SiP, C19010)

NEW: K58 R920
CuNi3SiMg, C70250

– High-Conductivity type alloys
K75 (CuCrSiTi C18070)
K88 (CuCrAgFeTiSi, C18080)

NEW: K75 83% IACS
CuCrSiTi, C18070

Newly developed high-performance alloys

The trend towards further miniaturization of connectors requires materials which provide higher strength than before. The new developed Wieland-K58, a C70250 Corson type alloy, provides tensile strength of minimum 920 MPa's.

Another trend is the increasing application of high-current connectors. Wieland-K75 was further developed to serve their needs. K75 now is available in a high-coductivity version with an electrical conductivity of minimum 83 % IACS while keeping its strength and relaxation properties on the high level.

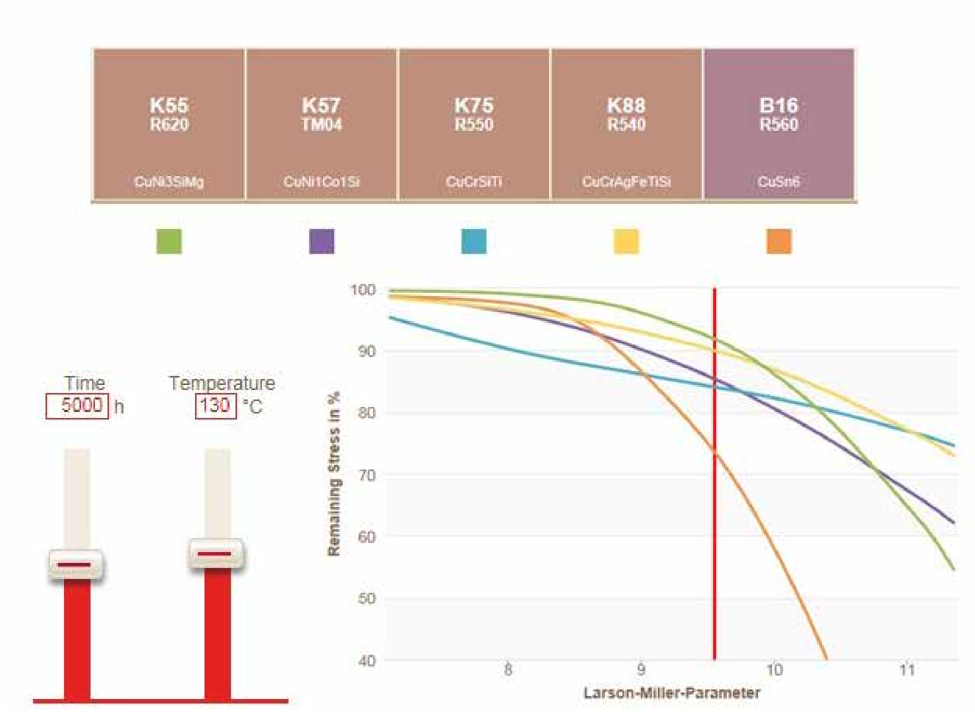

Fig. 4:
Thermal-stress relaxation diagram of high-performance alloys in compression with phosphor bronze.
Source: www.wieland-alloywizard.com

Brass and Special Brass

Brass is a copper-zinc alloy with a zinc content of up to 38 %. The main advantage of brasses is their comparatively low metal price, because zinc is significantly cheaper than copper. Special brasses, contain additional elements which help to increase strength and thermal properties. However, there are various disadvantages, such as low-temperature resistance, susceptibility to stress-corrosion cracking and the risk of zinc evaporation during arc welding. Therefore brass and special brass is applied in uncritical connectors only.

- Typical brasses are Wieland-M30 (CuZn30, C26000) and Wieland-M36 (CuZn36, C27000).
- Typical special brasses are Wieland-S12 (CuZn9Sn3, C42500) and Wieland-S23 (CuZn23Al3Co, C68800).

Phosphor bronze

Phosphor bronzes are alloys of copper and tin. Bronzes have an advantageous combination of properties of good strength, good formability and a certain resistance to thermal relaxation, which allows an application up to approx. 100 °C. Thus, bronzes established themselves very well as base materials in spring connectors, press-fit connectors and other contacts for the transmission of signals.

- Typical phosphor bronzes are
  Wieland-B14 (CuSn4, C51100)
  Wieland-B16 (CuSn6, C51900)
  Wieland-B18 (CuSn8, C52100)

Fine-grain bronze

Wieland SUPRALLOY® B14, B16, B18 are the fine-grain versions of the standard phosphor bronzes CuSn4, CuSn6 and CuSn8. They have the same UNS numbers as the standard bronzes, see above. The microstructure has fine-grain sizes of 1–3 µm. This results in higher strengths paired with a considerably better formability.

With the same formability, the yield strength of fine-grained bronze is approximately 120 MPa higher. In addition, the fine-grained bronze can withstand significantly increased cyclic load (higher fatigue resistance, higher vibration resistance).

Copper-Nickel-Tin alloys

This specialty of copper-nickel tin alloys is the very high strength in combination and very good relaxation resistance, also combined with good formability. Typical alloys are Wieland-L49 (CuNi9Sn2, C72500) and Wieland-L96 (CuNi9Sn6, similar to C72700).

Wieland-L96 aims for applications in which traditionally CuBe1.7, CuBe2 and CuTi3 is used. Typical applications are miniaturized signal connectors, springs in mobile phones and grounding contacts in consumer electronics and datacom.

Fig. 5:
Automotive connectors stamped from tinned strip

Material designations

Wieland	DIN	EN		ASTM	JIS
	Designation	Designation	Number	UNS No.	JIS No.
Copper					
K09	OFE-Cu	–	CW009A	C10100	C1011
K11	OF-Cu	Cu-OF	CW008A	C10200	–
K12	SE-Cu 57	Cu-HCP	CW021A	C10300	–
K14	SECu- 58	Cu-PHC	CW020A	C10300	–
K15	SW-Cu	Cu-DLP	CW023A	C12000	C1201
K19	Sf-Cu	Cu-DHP	CW024A	C12200	C1220
K32	E-Cu 58	Cu-ETP	CW004A	C11000	C1100
High-copper alloy					
K65	CuFe2P	CuFe2P	CW107C	C19400	–
K80	CuFe0,1P*	CuFe0,1P**	–	C19210	–
K81	CuSn0,15*	CuSn0,15	CW117c	C14415	–
High-performance copper alloy					
NEW K55/K58 high-strength	CuNi3SiMg*	CuNi3SiMg**	–	C70250	–
K57	CuNiCo1Si*	CuNiCo1Si**	–	C70350	–
K73	CuNi1ZnSi*	CuNi1ZnSi**	–	C19005	–
NEW K75/K75 high-conductivity	CuCrSiTi	CuCrSiTi	–	C18070	–
K76	CuNi1SiP*	CuNi1SiP**	–	C19010	–
K88	CuCrAgFeTiSi*	CuCrAgFeTiSi**	–	C18080	–
Brass					
M05	CuZn5	CuZn5	CW500L	C21000	C2100
M10	CuZn10	CuZn10	CW501L	C22000	C2200
M15	CuZn15	CuZn15	CW502L	C23000	C2300
M20	CuZn20	CuZn20	CW503L	C24000	C2400
M30	CuZn30	CuZn30	CW505L	C26000	C2600
M33	CuZn33	CuZn33	CW506L	C26800	C2680
M36	CuZn36	CuZn36	CW507L	C27000	C2700
M37	CuZn37	CuZn37	CW508L	C27200	C2720
M38	CuZn38	CuZn38	CW508L	C27200	C2720
Special brass					
S12	CuSn3Zn9*	CuSn3Zn9	CW454K	C51100	C5111
S23	CuZn23Al3Co*	CuZn23Al3Co	CW703R	C68800	–
Phosphor bronze					
B14	CuSn4	CuSn4	CW450K	C51100	C5111
B15	CuSn5*	CuSn5	CW451K	C51000	C5102
B16	CuSn6	CuSn6	CW452K	C51900	C5191
B18	CuSn8	CuSn8	CW453K	C52100	C5212
CuNi-alloy					
L49	CuNi9Sn2	CuNi9Sn2	CW351	C72500	–
L96	CuNi9Sn6	CuNi9Sn6		similar to C72700	

* material not-standardized in accordance with DIN

** material not-standardized in acc. with EN

Hot-dip tin coated strip

Hot-dip tin coating is an economical method to provide copper and copper alloy strip with a well adhering and multi-functional tin layer.

SnPUR® is the standard hot dip tin coating type. It consists of two layers, the intermetallic phase (IMP) adhering to the base metal and the free tin top layer. The IMP makes the coating resistant against whisker formation. The free tin layer ensures good electrical contact.

SnTEM® type coating consists of IMP only and thus provides a higher surface hardness. It is applied in cases when reduced mating forces and low tool wear is required.

SnTOP® type coating contains a certain low percentage of Ag which allows application at temperatures up to 160 °C.

For detailed information please see the brochure "Hot-dip tinned copper and copper alloy strip" on our website.

Fig. 6:
Hot-dip tinned strip

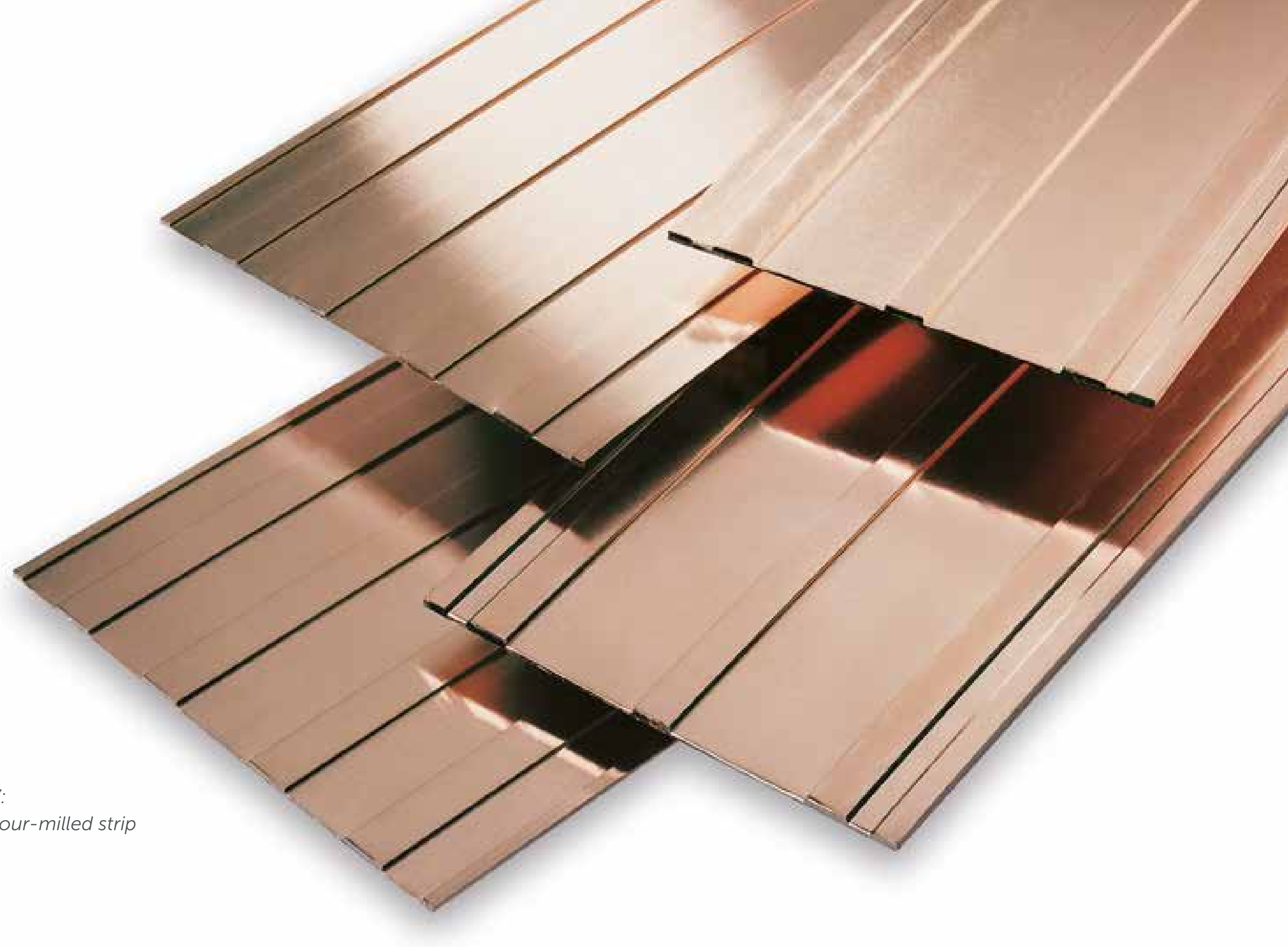

Fig. 7:
Contour-milled strip

Contour-milled strip

Contour milling is a process to produce dual-gauge and multi-gauge strip. This type of strip opens up new possibilities of producing electromechanical components with sections of different thicknesses. They no longer have to be joined from different stamped parts but can be stamped in one operation. Coining in the stamping tool is no longer necessary.

For detailed information please see the brochure "Multi-gauge strip" on our website.

Dimensions and Tolerances

Tolerances

Wieland's customers process strips using high-precision equipment which makes particular demands on the tolerances and the geometric properties of the strip. Thickness and width tolerances can be restricted to the tightest of margins compared with the relevant standards. Special measures can be taken during strip production in order to minimise shape deviations such as longitudinal camber, coil set or cross bow. With this, the particular requirements of the tool can be anticipated and accounted for.

Strip-thickness tolerances

Strip-thickness		Strip-thickness tolerance		
mm		mm		
		Precision level acc. to production costs		
over	up to	I	II	III
0.10	0.30	+/–0.010	+/–0.07	+/–0.005
0.30	0.50	+/–0.015	+/–0.010	+/–0.007
0.50	0.80	+/–0.020	+/–0.015	+/–0.010
0.80	1.30	+/–0.025	+/–0.020	+/–0.015
1.30	1.50	+/–0.030	+/–0.025	+/–0.020
1.50	on request			

Strip-width tolerances

Strip-thickness		Width-tolerance according to EN 1625		
mm		mm		
		Strip width		
over	up to	up to 50	over 50 up to 100	over 100 up to 200
0.10	1.0	+0.20 / –0	+0.30 / –0	+0.40 / –0
1.0	2.0	+0.30 / –0	+0.40 / –0	+0.50 / –0
2.0	2.5	+0.50 / –0	+0.60 / –0	+0.70 / –0
2.5	3.0	+1.00 / –0	+1.10 / –0	+1.20 / –0
3.0	4.0	+2.00 / –0	+2.30 / –0	+2.50 / –0

For strip thicknesses of up to 0.6 and strip widths of up to 100 mm, tolerances of half the values listed above can be supplied on request.

Camber

Strip thickness		Camber according to EN 1654			
mm		mm			
		Strip width			
over	up to	> 3–6	> 6–10	> 10–20	>20–350
0.10	0.50	12	8	4	2
0.50	1.00	–	10	6	3

Increased work in manufacturing allows the camber of a strip to be reduced to the following tolerances:

Strip thickness		Camber according to EN 1654			
mm		mm			
		Strip width			
over	up to	> 3–6	> 6–10	> 10–20	>20–350
0.10	0.50	7	5	3	1.0
0.50	1.00	–	6	4	1.5

Delivery Formats and Packaging

Strip in coils

Coils are the simplest and therefore the most economical delivery format for strip. They are packed horizontally on square or round pallets, the size of which is adjusted to the outer diameter of the coils.

Fig. 8: Strip in coils

Taverse-wound strip

Traverse-wound strip comes in coils which are welded together using the TIG process and then wound onto a drum. The resulting strands are considerably longer than with individual coils. The advantage is a reduction in the operator's changeover times. The welds are marked in colour.

Fig. 9: Drums with and without flanges

Wieland-MULTICOIL®

Wieland-MULTICOIL is packed with all the coils in a stack joined with each other to produce the longest possible strip length. With this method a whole stack of coils can be processed in a single stamping run. Uncoiling can be done on existing horizontal decoilers, so no investment is needed in equipment. The advantages:

- stamping runs with less downtime
- reduced risk of tool break at coil feedings
- higher productivity

Sizes and weights

Strip thickness	Strip width
0.20–0.80 mm	10–60 mm
0.81–1.20 mm	10–40 mm

Maximum pallet weight 5 t

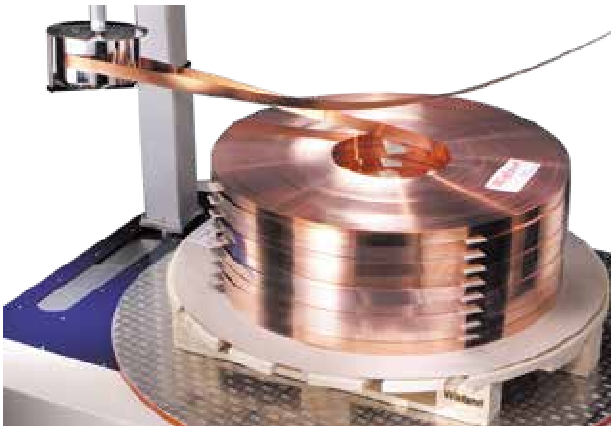

Fig. 10: Wieland-MULTICOIL

Wieland-FLEXIDRUM®

Drum logistics, too, can be improved even further. Wieland's latest contribution is called FLEXIDRUM. Removable and re-usable spool flanges are retained by the customer. The coils are delivered on cores without flanges, and so the flanges can be fitted very simply on the spot without having to lift the core. The cores can be supplied either as reusable or one-way cores.

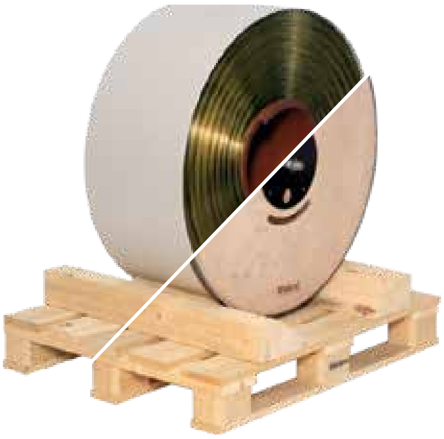

Fig. 11: Wieland-FLEXIDRUM

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