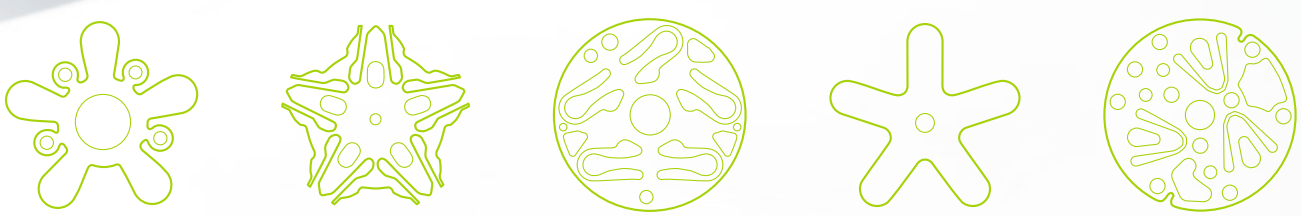
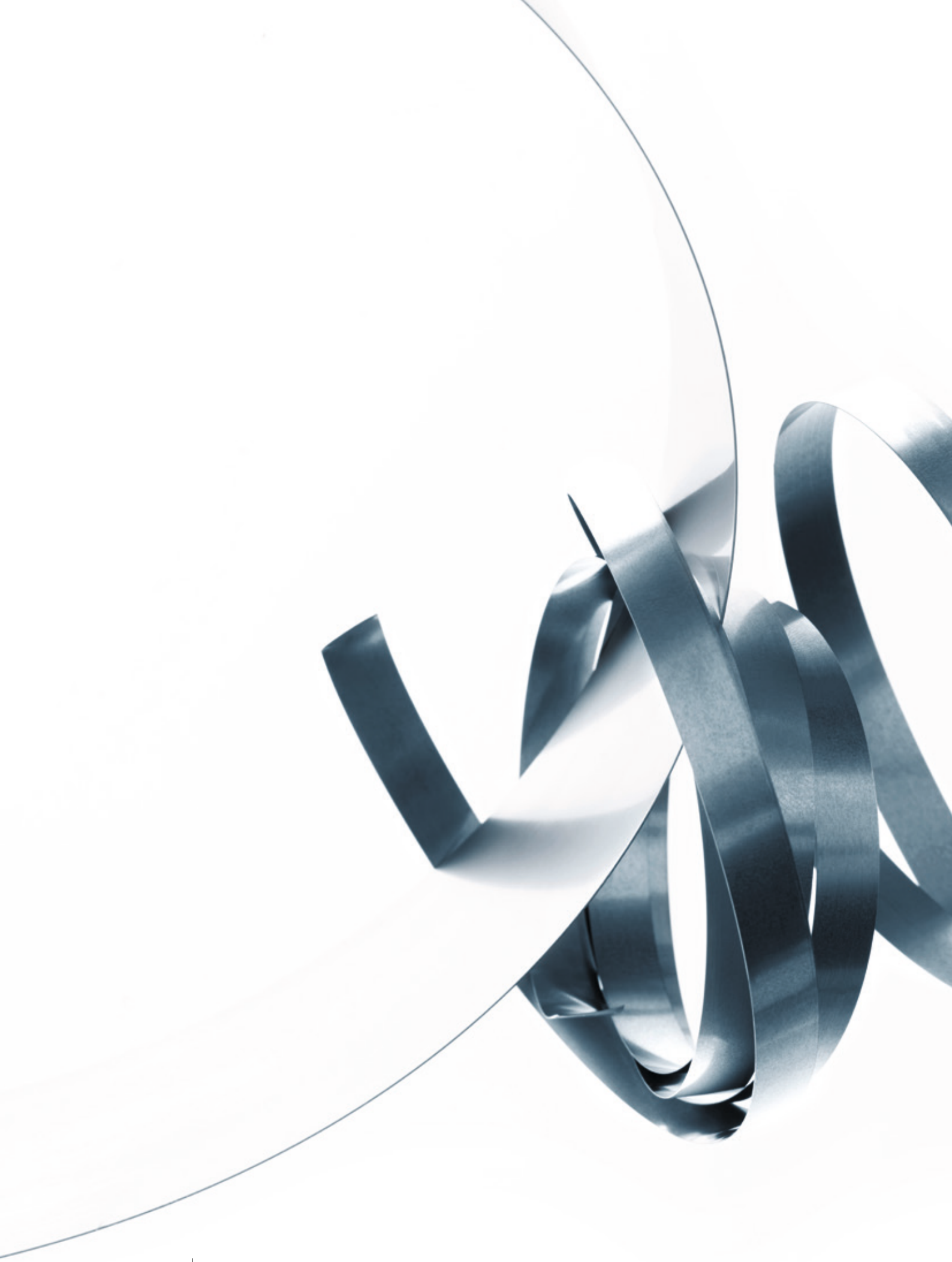
PRECISION STRIP

FLAPPER VALVES

Zapp Precision Metals GmbH





CONTENTS

ZAPP STEEL
OVER GENERATIONS – FOR FUTURE GENERATIONS

PRECISION STRIP FOR FLAPPER VALVES

Precision strip used for flapper valves must fulfill a variety of conflicting properties. In cooperation with compressor manufacturers, Zapp has developed steel grades to meet the most challenging demands for flapper valves.

The demanding requirements on dynamic properties, such as bending and impact fatigue, can only be met by defining accurate processes from the liquid steel to the final delivery to the customer. For over a century Zapp has worked with stainless steel developers to define the highest precision for its customers.

HOW DO WE MEET THE REQUIREMENTS FOR FLAPPER VALVES

The requirements of flapper valves are manifold and defined mainly by long life under dynamic bending, impact, and temperature together with any corrosive atmospheres:

_ Extended fatigue life under bending and impact loads
_ High degree of dimensional stability and high sag resistance to ensure complete sealing
_ Excellent surface finish
_ High compressive stresses at the surface
_ Good flatness and uniform distribution of stresses in the plane, to enable easy blanking and processing

The extended fatigue life is obtained by
_ Clean steel with the lowest possible amount of nonmetallic particles
_ Optimized and balanced microstructure
_ Very high strength and high ductility
_ Good wear resistance
_ Modern equipment for reproducible quality and tightest tolerances
_ Automatic surface inspection

APPLICATIONS AND STEEL GRADES

APPLICATIONS

Zapp's precision strips are used for most demanding applications in …

_ Air conditioners
_ Cars
_ Heat pumps
_ Industrial cooling systems
_ Refrigerators and freezers
_ Wine coolers

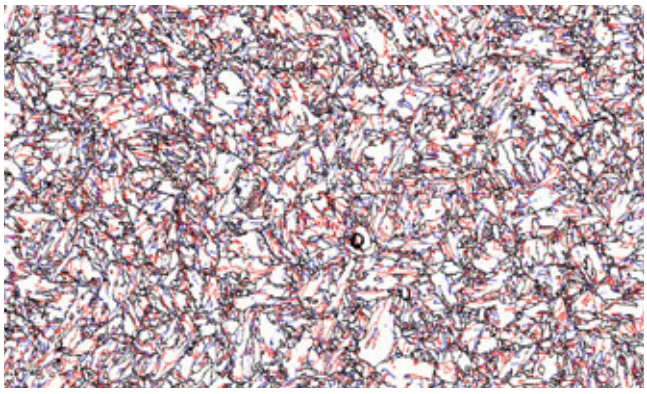
and many other consumer and commercial applications. Due to the high bending and fatigue properties Zapp's material is used by well-known global compressor manufactures. Excellent, reproducible quality and delivery performance are the foundations of our company.

STEEL GRADES

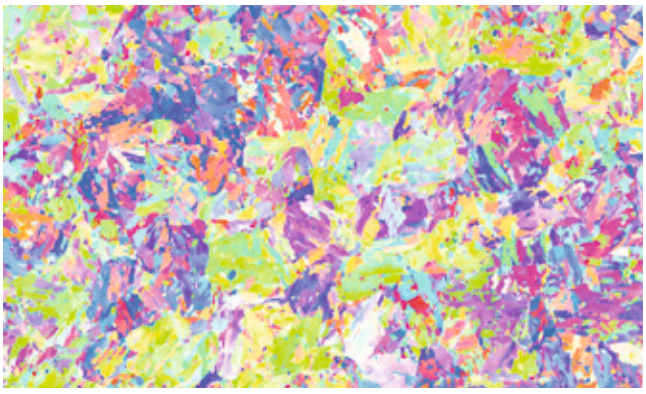
ZAPP® 1.1274QA is a martensitic carbon steel with 1.0 % carbon, exhibiting the highest fatigue strength among other unalloyed steels used for similar applications.

ZAPP® 1.4028MO is a martensitic stainless steel with 0.38 % carbon, 13.5 % chromium and 1 % molybdenum with high fatigue strength. It is used when superior corrosion or wear resistance is required and exposure to elevated temperature is expected.

ZAPP® SF is based on 1.4028MO but exhibits a special tailored microstructure for even higher bending and impact fatigue strength. SF stands for super fatigue due to its 10 % higher fatigue limit and higher impact fatigue than Zapp® 1.4028MO.



Grain boundaries in a hardened and tempered Zapp 1.4028MO



Crystal orientation map of hardened and tempered Zapp 1.4028MO

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Dr. Paul Campbell
Sales Manager, Precision Strip

CHEMICAL COMPOSITION AND MECHANICAL PROPERTIES

CHEMICAL COMPOSITION (WEIGHT %)

Alloy	C	Si	Mn	P	S	Cr	Mo
Zapp® 1.1274QA	1.00	0.25	0.40	≤ 0.015	≤ 0.005	0.20	–
Zapp® 1.4028MO	0.38	0.45	0.40	≤ 0.025	≤ 0.005	13.5	1.0
Zapp® SF	0.38	0.45	0.40	≤ 0.025	≤ 0.005	13.5	1.0

MECHANICAL PROPERTIES

_ Various combinations of strength and ductility are possible. These are not limited to the values presented in the table below.

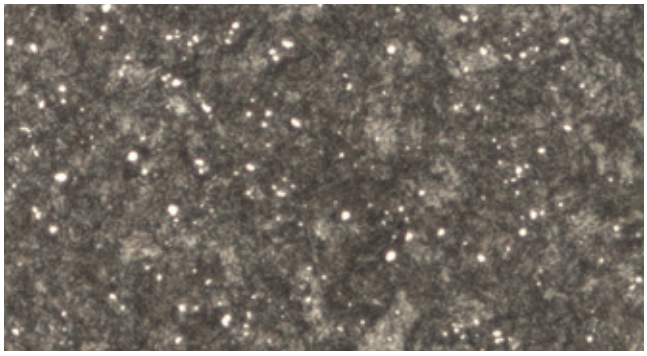
_ Based on our process control and monitoring, we can offer very tight ranges of properties, resulting in minimal process variation in the customer's production.

MECHANICAL PROPERTIES

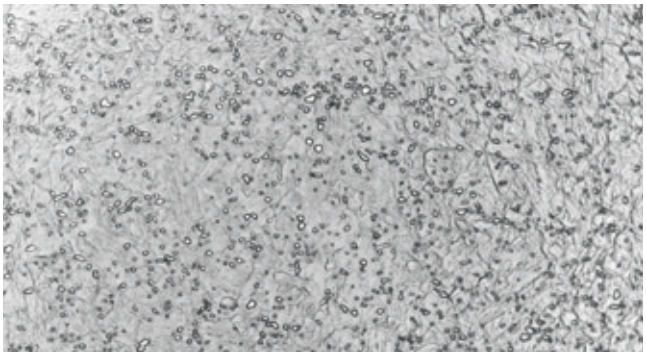
Alloy	Tensile Yield Strength [MPa]	Ultimate Tensile Strength [MPa]	Elongation [%]	Hardness [HRC]
Zapp® 1.1274QA	1350 to 2000	1550 to 2200	≥ 3	48 to 59
Zapp® 1.4028MO	1350 to 1550	1700 to 1900	≥ 5	50 to 55
Zapp® SF	1400 to 1600	1800 to 2000	≥ 6	54 to 57

Uniform tailored microstructures, over coil length and width and across all lots, are achieved by the use of modern measuring equipment and tight process parameter control. We provide our customers with materials exhibiting the smallest variations of static and dynamic mechanical properties, as well as the best possible corrosion performance.

A very fine martensitic microstructure, with a fine dispersion of carbides and a controlled phase balance, is the key in achieving the optimum combination of strength and ductility of our material. A further improvement of the microstructure led to the creation of a grade with superior fatigue properties, our new »Zapp® SF«.



Zapp® 1.1274QA, hardened and tempered



Zapp® 1.4028MO, hardened and tempered

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Anselmo Gara
Supervisor | Production Mill Europe

FATIGUE AND CORROSION PROPERTIES

FATIGUE PROPERTIES

_ Tests conducted together with our customers have shown that our flapper valve strips not only meet their specifications, but exhibit the lowest performance variation in their category.

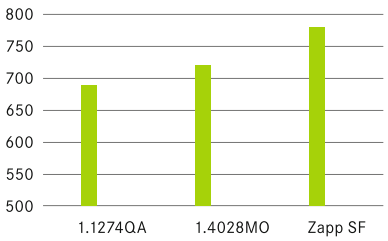
_ Due to compressive stresses, near the material surface, the fatigue performance is best in the polished condition.

_ Our newest development, the Zapp® SF grade exhibits a 10 % higher fatigue limit in reverse bending mode and significant higher impact resistance than Zapp® 1.4028MO.

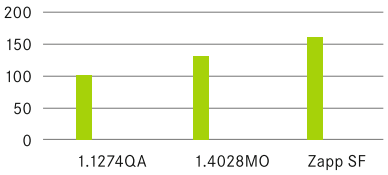
CORROSION RESISTANCE

Zapp® 1.4028Mo and Zapp® SF are both alloyed with molybdenum and thus deliver superior corrosion performance compared to the typical ASTM 420 type grades. They are stable in most diluted solutions of acids and salts. In corrosive environments the fatigue and impact life is significantly higher than that of the unalloyed grade 1.1274QA. The corrosion resistant is further improved by high gloss polishing.

FATIGUE LIMIT IN REVERSED BENDING
Stress (MPa)



IMPACT FATIGUE
Percentage (%)



PHYSICAL PROPERTIES

	Physical properties
Density p	7.7 [g/cm³]
Modulus of elasticity	20°C 215 [GPa]
	100°C 212 [GPa]
	200°C 205 [GPa]
	300°C 200 [GPa]
	400°C 190 [GPa]
Poisson ratio ν	0.32
Thermal expansion coefficient between 20°C and ...	100°C [10.5 · 10^{-6}, K^{-1}]
	200°C [11.0 · 10^{-6}, K^{-1}]
	300°C [11.5 · 10^{-6}, K^{-1}]
	400°C [12.0 · 10^{-6}, K^{-1}]
Thermal conductivity at 20°C	30 [W/m · K]
Specific heat capacity at 20°C	460 [J/kg · K]
Electrical resistance at 20°C	0.65 [Ω mm²/m]
Magnetism	existing

SURFACE FINISH AND DIMENSIONS

DELIVERY FORM
_ Coil
_ Sheet
_ Spool

CONDITION
_ Cold rolled
_ Cold rolled and annealed (bright finish)
_ Cold rolled, hardened and tempered (bright finish)
_ Cold rolled, hardened, tempered (bright finish), and polished

EDGE
_ Slit
_ Deburred
_ Rounded

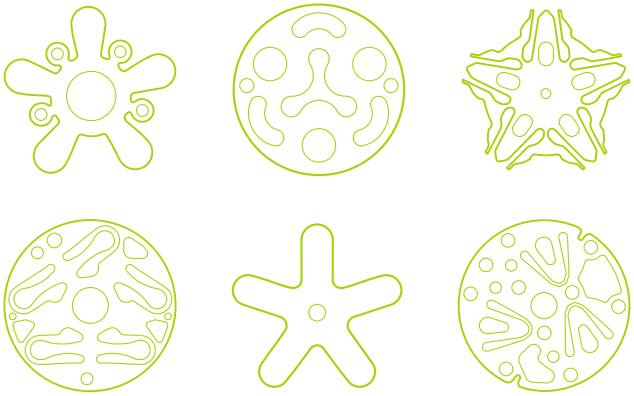
SURFACE FINISH
_ Bright
_ Polished
_ Special

ROUGHNESS
Depending on requirement
_ 0.05 µm ≤ R_a ≤ 0.30 µm
_ 1.0 µm ≤ R_t ≤ 3.0 µm

DIMENSIONS
_ Thickness: 0.08 mm to 1.5 mm
_ Width: 4 to 320 mm

FLATNESS
_ Flatness in rolling direction (waviness) max. 3 I-Units
_ Flatness in transverse direction (cross bow) max. 0.20 % of the width

STRAIGHTNESS
_ max. 1.5 mm/m and tighter if required

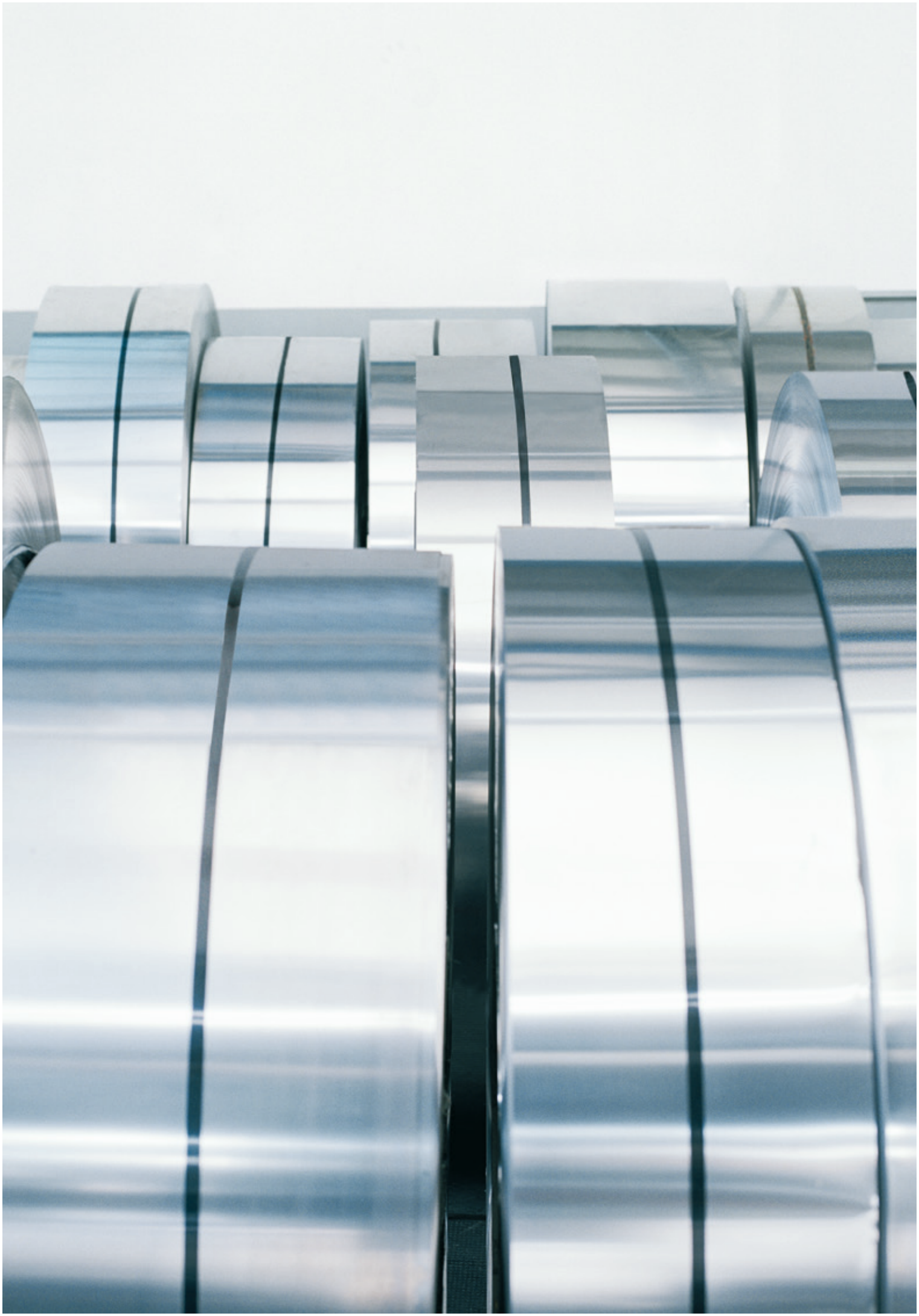


Many possible forms of flapper valves can be achieved by our Zapp material.

THICKNESS TOLERANCES

THICKNESS TOLERANCES ± 1/1000 MM

Thickness [mm]	Width [mm]	T1	T2	T3	T4	T5
0.08 – 0.099	– 250	6	5	4	3	2
	251 – 400	7	6	5	4	3
0.100 – 0.124	– 250	7	5	4	3	2
	251 – 400	9	6	5	4	3
0.125 – 0.159	– 250	9	6	5	4	3
	251 – 400	10	7	6	5	4
0.160 – 0.199	– 250	10	7	5	4	3
	251 – 400	11	8	6	5	4
0.200 – 0.249	– 250	11	8	6	4	3
	251 – 400	13	9	7	6	5
0.250 – 0.314	– 250	13	9	7	5	4
	251 – 400	15	11	8	6	5
0.315 – 0.399	– 250	15	11	8	6	4
	251 – 400	17	12	9	6	5
0.400 – 0.499	– 250	17	12	9	6	4
	251 – 400	20	14	10	7	5
0.500 – 0.629	– 250	20	14	10	7	5
	251 – 400	24	17	12	9	6
0.630 – 0.799	– 250	23	17	12	8	6
	251 – 400	27	20	14	10	7
0.800 – 0.999	– 250	27	19	13	9	7
	251 – 400	32	23	16	12	8
1.000 – 1.249	– 250	34	24	17	12	8
	251 – 400	36	26	18	13	9
1.250 – 1.500	– 250	36	28	20	14	9
	251 – 400	44	32	22	16	11



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