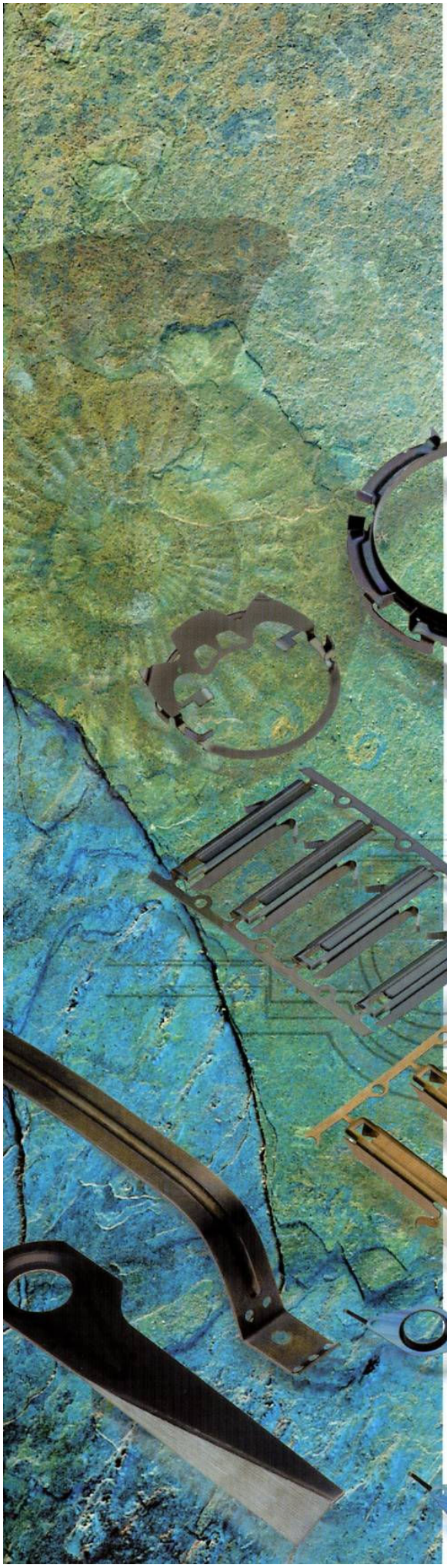


KALTWALZWERK
BROCKHAUS

Brockhaus
PT-Strip

Bainite hardened cold rolled strip for

punched, bent and formed parts

without | **piece hardening**

Requirements

The successful sales of flat and formed springs prerequisite:

- functional spring properties
- form corresponding to drawing
- competitive prices
- simultaneous engineering

Advantages

- no time consuming and expensive heat treatment
- no part distortion and hardening cracks
- reduction of scrap parts
- reworking and inspection will be minimised or eliminated
- the formed springs can be directly assembled in modules in integrated production processes

Solution

Brockhaus PT-Strip offers

- the production of punched, bent and formed components starting from 0.20 mm thickness in one operation
- punching, bending and deep drawing processing at tensile strength corresponding to martensite hardening

What is PT-Strip?

Heat treatment methods

Martensite hardening	Bainite hardening
Austenitizing Quenching	
below the Martensite temperature	in a warm bath isothermal austenite transformation
Tempering	
Cooling to room temperature	

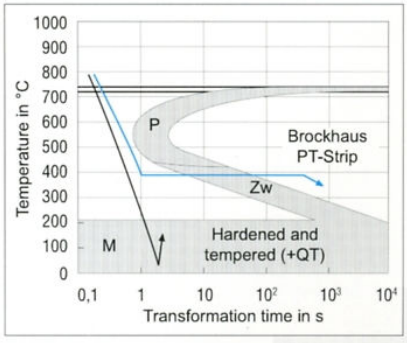
Brockhaus PT-Strip is an austempered steel strip (Bainite).

The heat treatment is effected in a continuous process with isothermal transformation in a metal bath.

PT-Strip was developed by Kaltwalzwerk Brockhaus in the early 80´s. PT means "pretempered". The following figure stands for the medium tensile strength in previously kp/mm².

Brockhaus PT-Strip has a excellent cold formability at high tensile strength.

Processing (schematic)



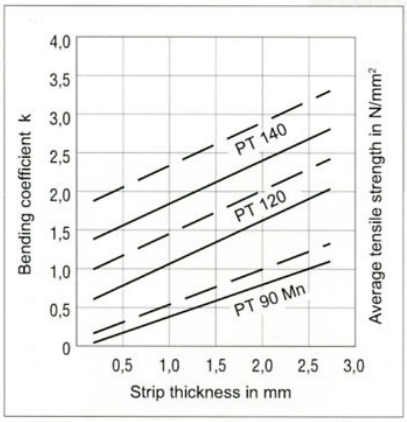
Bendability [5]

Slight differences between longitudinal and transversal bends

- homogeneous and fine grained microstructure
- raw material with defined cleanliness

We recommend to place the burr inside the bending radius.

Referent values for the practical calculation of 90°- bends



Mechanical properties [6]

Tensile range:
800 - 1600 N/mm²
Elastic ratio:
80 - 85% after heat treatment
Elongation at fracture:
depending on tensile more than 20%

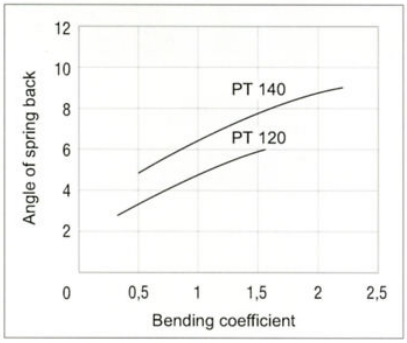
Because of the special micro-structure the hardness values are lower compared to martensitic hardened materials. We do not recommend to convert the hardness into tensile strength according to DIN 50 150. The tensile strength is the inspection criteria.

Spring back [6]

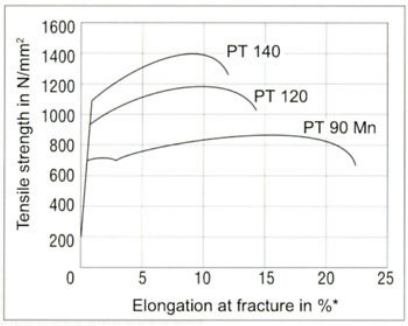
Stronger overbending caused by elastic limit compared to annealed materials is necessary.

The angle of spring back increases with rising bending coefficient.

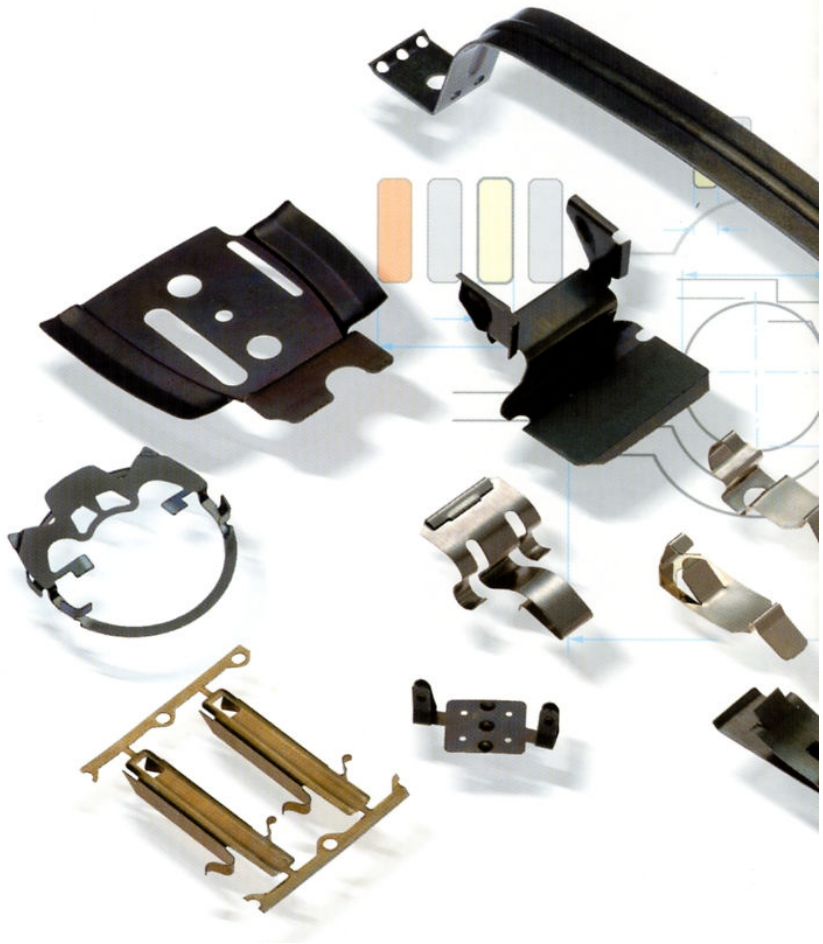
Spring back characteristics after 90°- bends



Real tension-elongation-diagrams according to tensile test following EN 10 002



* Original gauge length $L_0 = 5{,}65 \sqrt{S_0}$



Punchability/Tools

Bending radius = Bending coefficient • strip thickness

$r = k \cdot s$

——— 90° - transversal bends

— — 90° - longitudinal bends

- normal punching
- fine blanking

The deviate shearing factor from the formula of the cutting force equals 0.7.

Examples for tools:

- HSS
- powdermetallurgical
- hard metal alloy

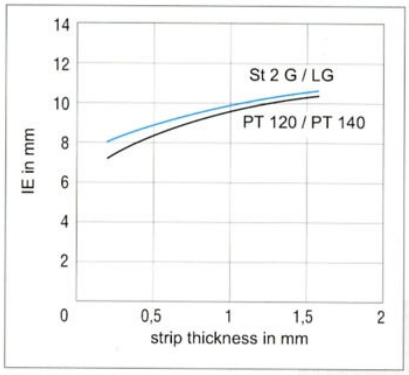
The grey-blue oxide film has hardly negative influence to tool life.

Formability/Anisotropy [6]

Ambitious forming operations for example hole profiles, forming by plunging, drawing calotte shells and stamping of beads are possible with **Brockhaus PT-Strip.**

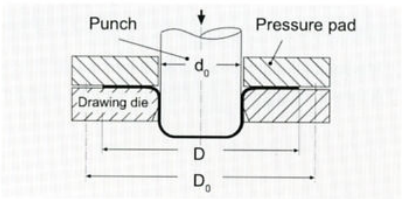
The characteristics of the Erichsen test in comparison with St 2 is corresponding with the former DIN 1624.

Drawing characteristics according to Erichsen test as per DIN 50101, Teil 1



The maximum drawing ratio of the cupping test exceeds or is over 2. The cups have the tendency of earing of maximum 0.35 mm.

Capping test (schematic)



Corrosion prevention

Surface planting

The oxide film guarantees no corrosive protection. Under consideration of the necessary condition against hydrogen embrittlement the surface can be plated as to traditional processes.

Fatigue strength

Referent values of the fatigue strength and the temperature depending pulsating bending fatigue limit are published in technical articles [7,8].

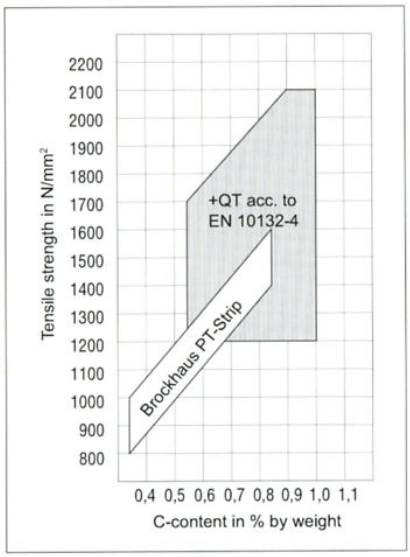
Standardising

Brockhaus PT-Strip is mentioned in the Stahl-Eisen-Liste [3]. The standard corresponds to the particular raw material grades of EN 10 132. The mechanical properties of spring steel according to EN 10 132-4 are also valid for the bainite hardened condition.

Brockhaus PT-Strip is an integrated part of order specifications of reputed suppliers to the car industry.

Grade and raw material schedule

Tensile range of heat treated carbon steel



Increase of tensile strength by:

- subsequent cold rolling (reduction of the formability)
- tempering of finished parts (enhancement of spring power)

Heat treatable and spring steel	**Martensite hardening[1] (+QT) acc. EN 10132-4**	**Bainite-hardening Brockhaus PT-Strip**	
Grade	Tensile strength N/mm²	Grade	Tensile strength[2] N/mm²
34 Mn 5		PT 90 Mn	800 - 1000
C 45 E		PT 100	900 - 1100
C 55 S	1100 - 1700	PT 110	1000 - 1200
C 60 S	1150 - 1750	PT 120	1100 - 1300
C 67 S	1200 - 1900	PT 130	1200 - 1400
C 75 S	1200 - 1900	PT 140	1300 - 1500
C 85 S	1200 - 2000	PT 150	1400 - 1600
C 90 S	1200 - 2100		
C 100 S	1200 - 2100		
55 Si 7	1200 - 1700		
51 CrV 4	1200 - 1800		

[1] Martensitic hardened strip is not in the Brockhaus delivery program

[2] A tensile range of 100 N/mm² can be agreed upon

Production program

Thickness:	0.20 - 3.00 mm
Width:	3.00 - 320 mm
Coil weight:	max. 10 kg/mm strip width
Edge conditions:	
GK	slit edge
SK	individual shape
Surface:	grey-blue

Kindly contact us if you have different requirements.

Do you have any questions concerning PT-Strip?

We would like to assist you.

Your partner

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