SIHARD S471

SPECIFICATION SHEET

The SIHARD S471 cold-work tool steel produced by SIJ Metal Ravne is a medium-chromium, air-hardening tool steel providing a very good combination of wear resistance and toughness. It is available primarily in round bars for cold-work tooling applications.

The SIHARD S471 steel excels itself in the following properties:

- a very good combination of wear resistance and toughness
- high hardness
- nitridability
- high dimensional stability

CHEMICAL COMPOSITION (AVERAGE % - TYPICAL ANALYSIS %)

Grade	C	Si	Mn	Cr	Mo	V	W
SIHARD S471	1.10	1.00	0.35	7.90	1.50	2.20	1.20

COMPARISON TO SIHARD 2379 (D2)

The SIHARD S471 is a premium tool steel with high wear resistance and toughness. Compared with the conventional SIHARD 2379 (AISI D2) steel, SIHARD S471 has a higher wear resistance, better hardenability and it can achieve higher hardness and toughness. Toughness is important to prevent cracking and chipping resulting in a catastrophic failure of tools. Toughness is better than in the conventional SIHARD 2379 (AISI D2) type of cold-work tool steel.

Abrasion resistance is critical when tool is exposed to hard foreign particles (crushing tools, tablet stamps) or metals contain-ing hard phases such as carbides (stamping and cutting tools), whereas chipping resistance is important for all cutting tools and knives.

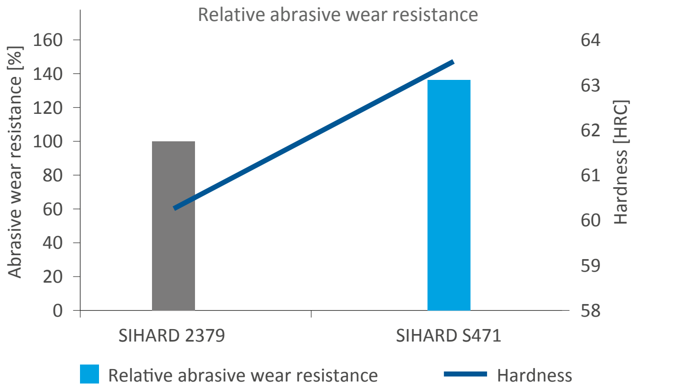

Fig. 1: Comparison of abrasive wear resistance of SIHARD S471 and SIHARD 2379, tested against allumina ball.

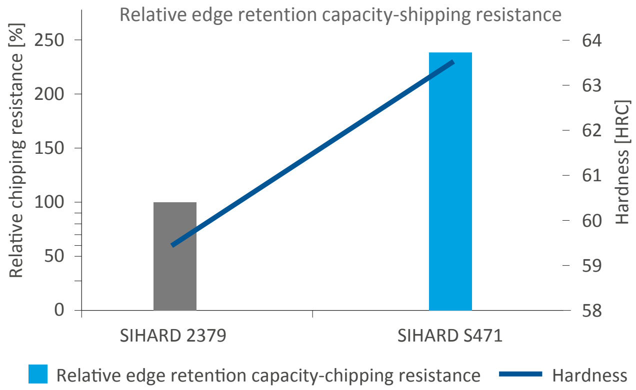

Fig. 2: Relative chiping resistance of cutting edge.

When in sliding contact with hard moving parts, steel is subject to adhesive wear (bushings, guide pins and shafts), which is mitigated by the rate of surface adjustment or run-in. When working with much softer materials (deep drawing, coining, stamping, upseting tools ...), gailling is the predominant wear mechanism.

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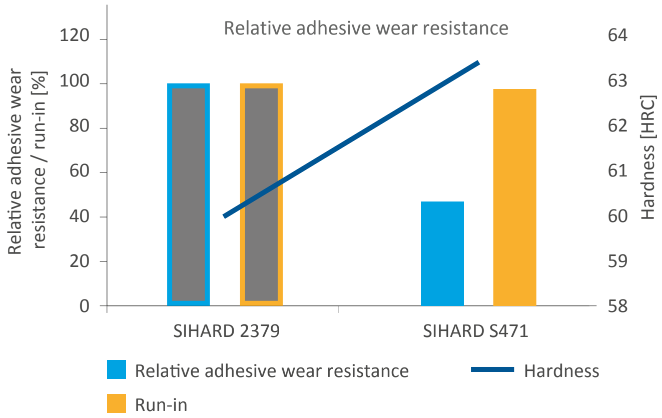

Fig. 3: Comparison of hardness, adhesive wear resistance and run-in for SIHARD S471 and SIHARD 2379, sliding against 58HRC bearing ball.

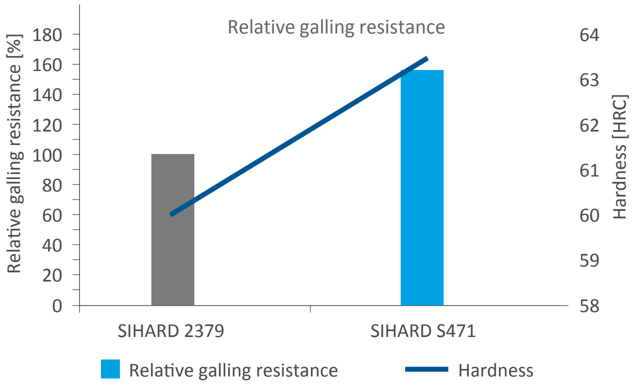

Fig. 4: Comparison of resistance to galling for SIHARD S471 compared with SIHARD 2379, sliding against structural steel (S235J2).

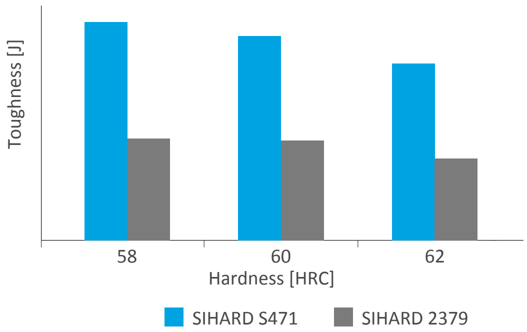

Fig. 5: Comparison of hardness and toughness

MICROSTRUCTURE

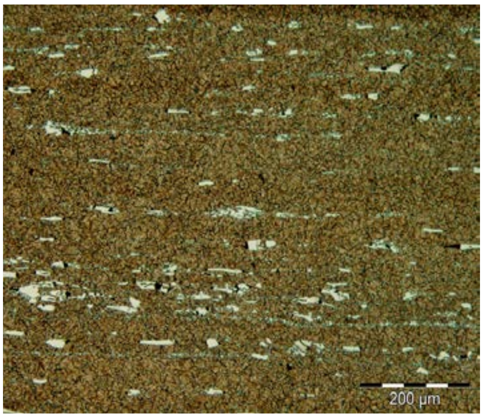

Fig. 6: Comparison of microstructure: SIHARD 2379 (left) and SIHARD S471 (right)

TEMPERING

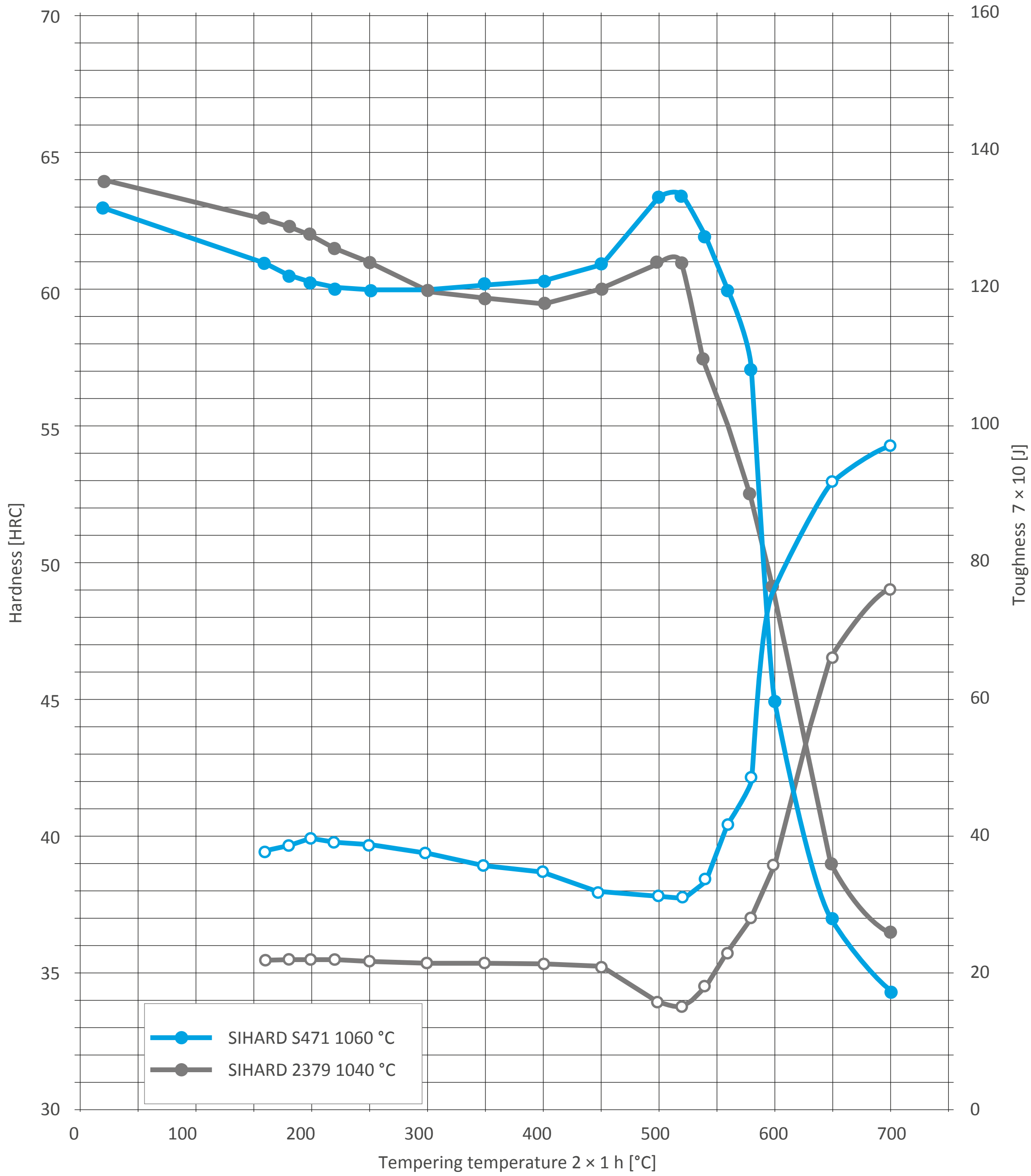

Fig. 7: Tempering diagrams

APPLICATIONS

Typical applications for SIHARD S471 cold-work tool steel:

- blanking dies
- thread roll dies
- punches
- coining dies
- drawing dies
- upsetting dies
- cutting tools
- cutting rolls
- cutting knives

HEAT TREATMENT

Annealing

All material is delivered in spheroidized annealed condition with max. 240 HB hardness.

When used after reforging, spheroidized annealing has to precede hardening.

Annealing must be performed after hot working and before rehardening.

Heat at a rate not exceeding 50 °C per hour to reach 820-860 °C, and hold at that temperature for 1 hour for every 25 mm of workpiece thickness; 2 hours minimum. Then cool down slowly in furnace to 600 °C at a rate not exceeding 20 °C per hour. Continue cooling to ambient temperature in furnace or in the air. The final hardness should be maximum 240 HB.

Hardening:

Preheating

To minimize distortion and stresses in large or complex tools use double preheat. Heat at a rate not exceeding 50 °C per hour to 620-680 °C for equalization, and then continue heating to reach 820-840 °C. For normal tools, use only the second temperature range as a single preheating treatment.

Austenitizing

Heat rapidly from the preheat.

Furnace or salt bath: 1040-1080 °C. Equalize and soak at austenitizing temperature for 30 minutes for pieces up to 25 mm in thickness, plus 15 minutes for each additional 25 mm of thickness.

For maximum toughness, austenitize from the lower recommended range of austenitization temperatures. For maximum wear resistance, austenitize from the upper recommended range of austenitization temperatures.

Quenching

1040 to 1080 °C / air, oil or inert gas. To increase hardness by 1 to 2 HRC and dimensional stability after quenching, sub-zero treatment may be used.

Tempering

Temper immediately after quenching (when material reaches temp. 90-70 °C). At least two tempering treatments are recommended to achieve a uniform tempered microstructure. Slowly heat to reach tempering temperature. Holding time in the furnace: 1 hour for every 25 mm of workpiece thickness, but 2 hours minimum. This is followed by air cooling. Typical tempering temperatures are 150 to 550 °C.

If surface treatment is to be applied, tempering temperature has to be 20-30 °C higher than the temperature at which steel is treated.

SURFACE TREATMENTS

To reduce friction and to increase wear resistance, surface treatment can be used. The recommended treatments are nitriding and surface coating with wear-resistant layers, for example via PVD.

Nitriding

Nitriding results in a hard surface layer which is highly resistant to wear and galling. The surface hardness after nitriding is approx. 1300 HV0.2.

PVD

Physical vapour deposition (PVD) is a method that applies wear-resistant coating at temperatures between 200 °C and 500 °C. PVD is a coating process for high-quality surface finishes. The coating produces an extremely hard surface which is characterised by its resistance. It is highly wear resistant. PVD TiN/(Ti,Al)N, CrN and TiN coatings have become important for several industrial applications at elevated temperature. It has been documented in literature that TiN, CrN and TiN(Ti, Al)N PVD coatings can reduce friction in tribological contacts and increase the abrasive wear resistance.

PHYSICAL PROPERTIES Heat treated: hardened and 2× tempered

Modulus of elasticity

MODULUS OF ELASTICITY (10^3 N/mm²)
At ambient temperature (20°C): 210

Density

DENSITY [g/cm³]
At ambient temperature (20°C):
7.65

Coefficient of Linear Thermal Expansion

COEFFICIENT OF LINEAR THERMAL EXPANSION (10^{-6} m /mK)						
20°C-100 °C	20°C-200 °C	20°C-300 °C	20°C-400 °C	20°C-500 °C	20°C-600 °C	20°C-700 °C
10.8	11.0	11.5	11.7	12.1	12.0	12.0

Specific heat capacity

SPECIFIC HEAT CAPACITY (J/gK)
0.47

Thermal conductivity

THERMAL CONDUCTIVITY (W/(mK))					
20 °C	200 °C	400 °C	500 °C	600 °C	700 °C
30	24.8	27	29		

CONTINUOUS COOLING TRANSFORMATION (CCT) DIAGRAM

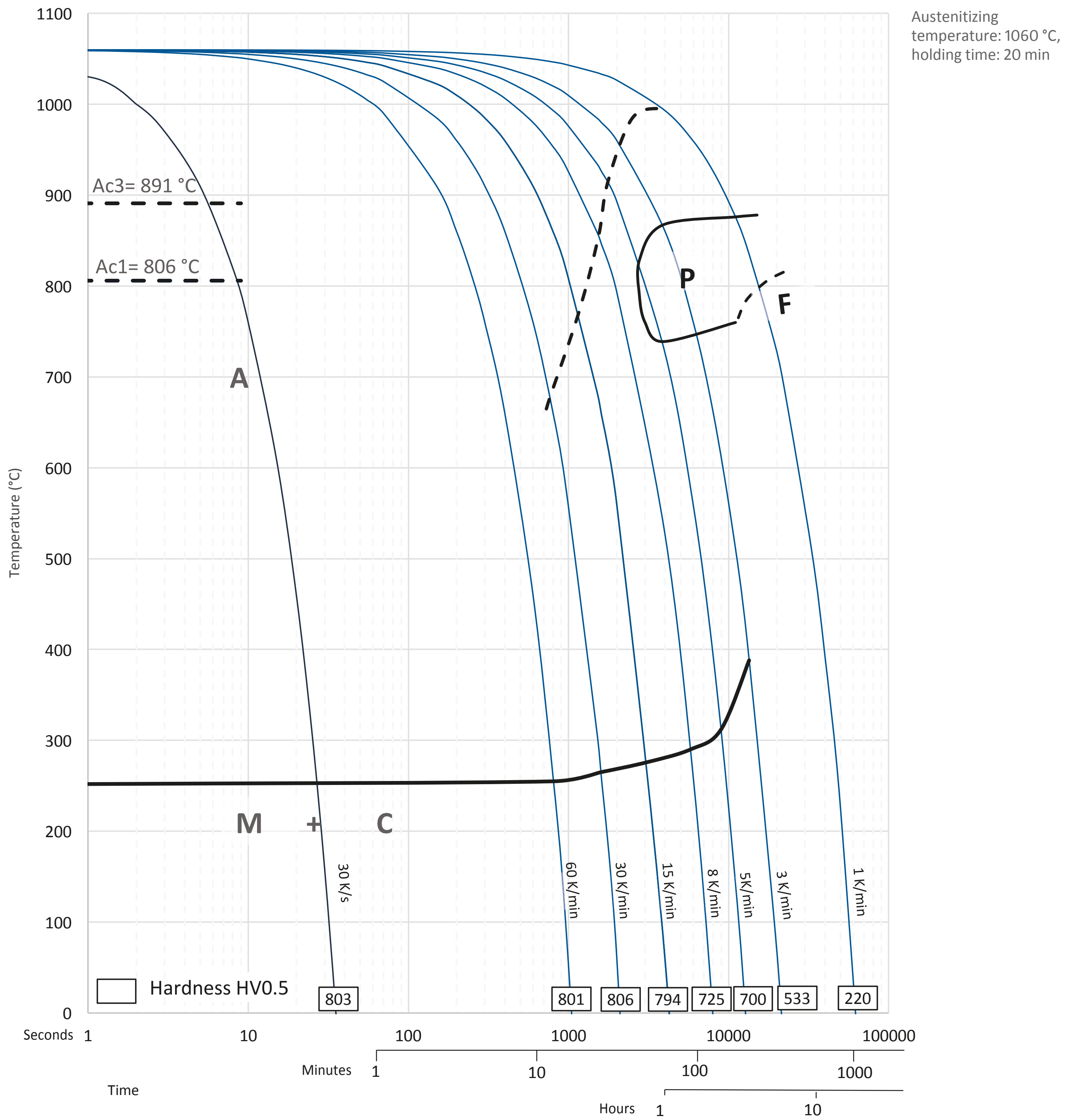

Fig. 8: Continuous Cooling Transformation (CCT) Diagram

TEMPERING DIAGRAM

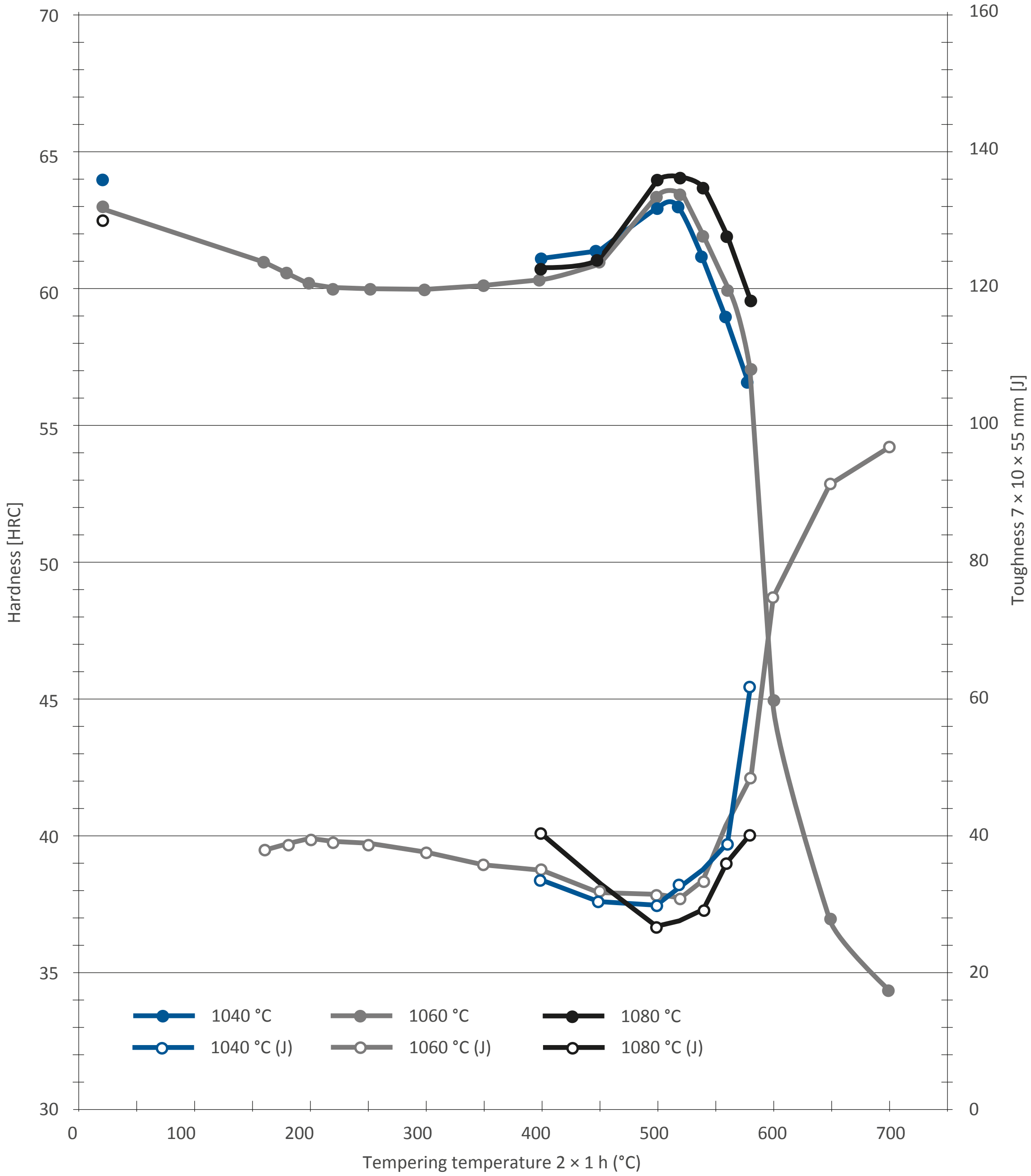

Fig.9: Tempering Diagram

DISCLAIMER

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