SIHARD K561

SPECIFICATION SHEET

The SIHARD K561 cold-work tool steel produced by SIJ Metal Ravne is a medium-chromium, air-hardening tool steel distinguished by an outstanding combination of hardness and toughness. This allows steel to achieve higher wear resistance compared to the industrial standard for cold-work steel SIHARD 2379 (AISI D2), under abrasion and especially adhesion conditions. This tool steel is particularly suitable for demanding applications in the production of knives and lean tools requiring a high degree of toughness.

The SIHARD K561 steel is characterized by the following properties:

- high abrasive wear resistance
- very high adhesive wear resistance
- outstanding toughness
- high dimensional stability due to low retained austenite content

CHEMICAL COMPOSITION (AVERAGE WEIGHT % - TYPICAL ANALYSIS %)

Grade	C	Si	Mn	Cr	Mo	V	W
SIHARD K561	0.55	0.85	0.3	8.5	1.6	0.25	1.1

COMPARISON WITH SIHARD 2379 (D2)

SIHARD K561 is a premium cold-work tool steel with greatly improved toughness and wear resistance. Compared to the conventional SIHARD 2379 (AISI D2) steel, SIHARD K561 has a higher wear resistance under abrasive conditions, whereas it greatly outperforms when subjected to adhesive wear or galling. This steel achieves a similar hardenability and it is capable of achieving a combination of very high toughness and hardness upon tempering which gives rise to a very high chipping resistance.

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

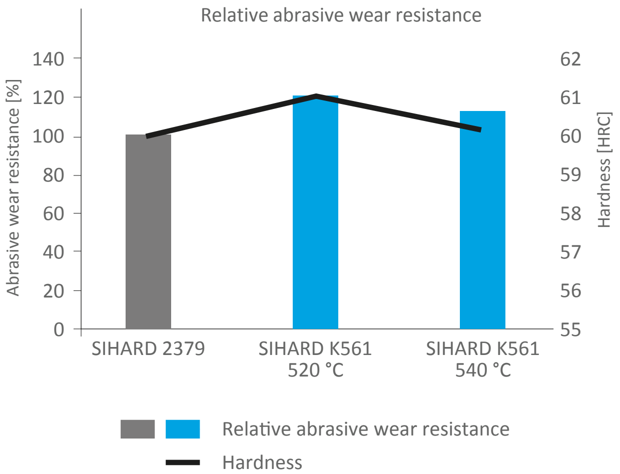

Fig. 1: Comparison of abrasive wear resistance between SIHARD K561 and SIHARD 2379, testing by sliding against allumina ball.

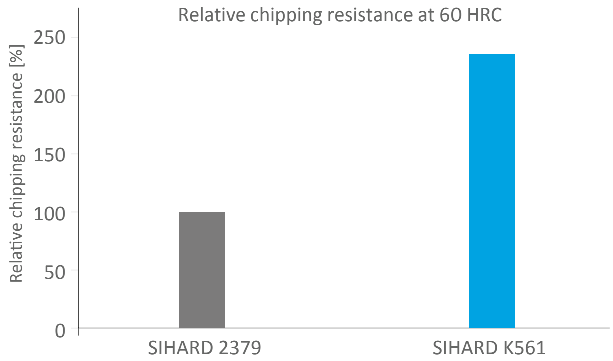

Fig. 2: Relative chipping resistance of cutting edge.

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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, upsetting tools ...), galling is the predominant wear mechanism.

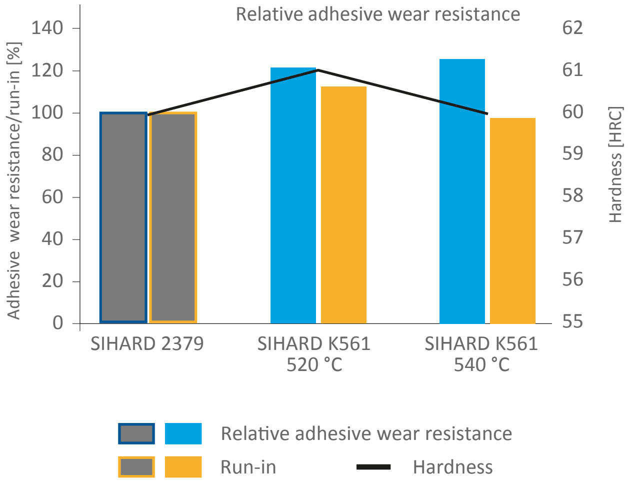


Fig. 3: Comparison of hardness, adhesive wear resistance and run-in of SIHARD K561 compared to SIHARD 2379, testing by sliding against 58 HRC bearing ball.

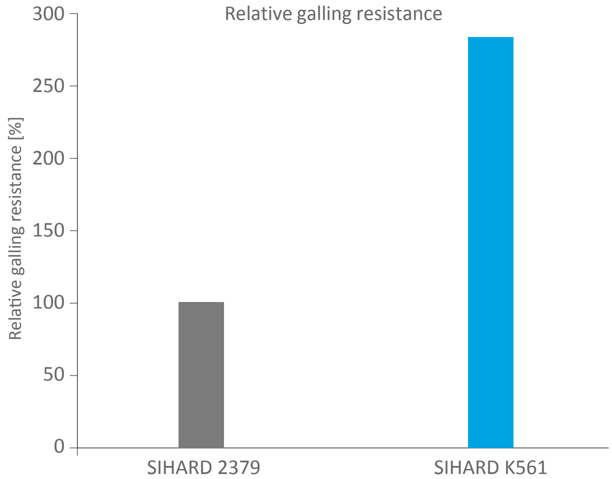
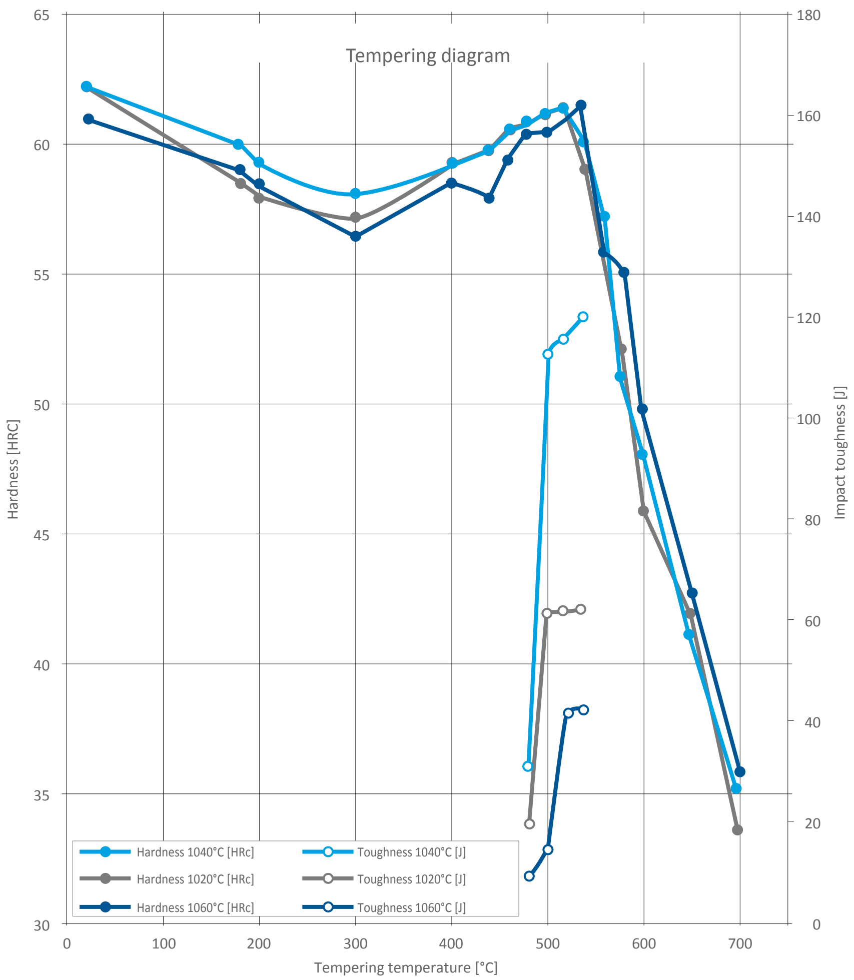


Fig. 4: Comparison of resistance to galling of SIHARD K561 compared to SIHARD 2379, testing by sliding against structural steel (S235J2).

TEMPERING



The recommended quenching temperature is 1040±10°C.

Fig. 5: Tempering diagrams of SIHARD K561, when quenched from different temperatures and double tempered 2x2h on a cube sample 20 mm – toughness measured on sample 7 × 10 mm.

Tempering diagram 1040°C/oil

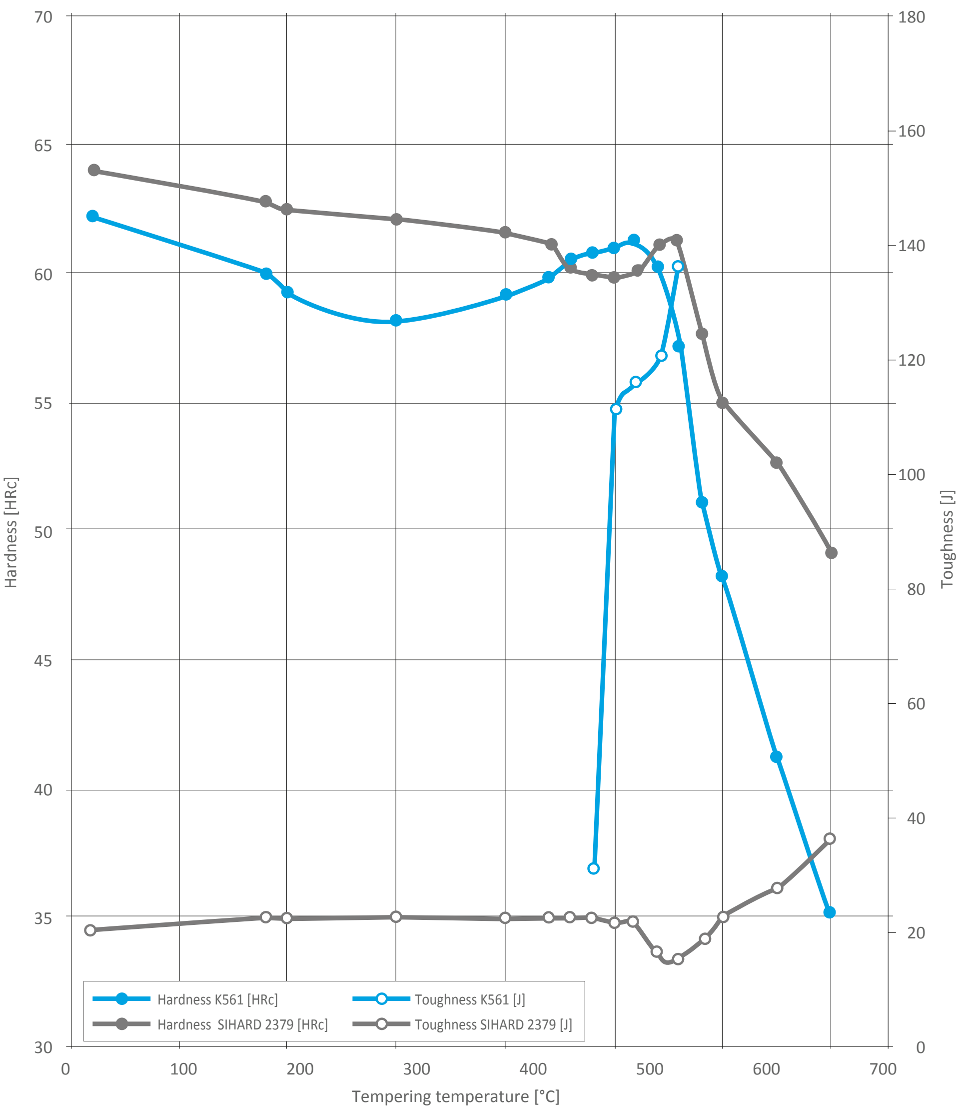


Fig. 6: Tempering diagrams of steel SIHARD K561, in comparison with SIHARD 2379, double tempered 2x2h on a cube sample 20 mm - toughness measured on sample 7 × 10 mm.

MICROSTRUCTURE

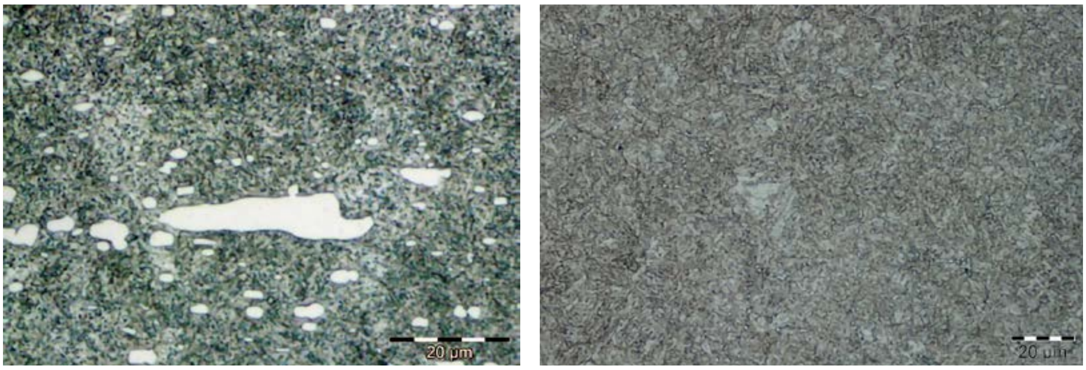


Fig. 7: Comparison of microstructure: SIHARD 2379 (left) and SIHARD K561 (right), showing a very fine carbide size of the new steel.

APPLICATIONS

Typical applications for SIHARD K561 cold-work tool steel:

- cutting tools
- cutting knives
- lean tools and punches requiring high toughness
- punches
- coining dies
- drawing dies
- upsetting dies

HEAT TREATMENT

Annealing

All material is delivered in spheroidized annealed condition with max. 250 HB hardness.

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 1 hour for every 25 mm of workpiece thickness; 2 hours minimum. Then cool slowly in furnace down 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 250 HB.

Hardening:

Preheating

Use double preheat to minimize distortion and stresses in large or complex tools. 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 temperature.

Furnace or salt bath: 1020-1050 °C. Equalize and soak at austenitizing temperature 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

Quench from a temperature between 1020 and 1050 °C / air, oil or inert gas. To increase hardness by 1 to 2 HRC and dimensional stability after quenching, a sub-zero treatment may be used by cooling steel below -100 °C.

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. Recommended tempering temperatures are in the range 460 to 550°C.

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

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 by 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 producing high-quality surface finishes. Coating produces an extremely hard surface, which is characterized by its high wear resistance. PVD TiN/(Ti,Al)N, CrN and TiN coatings have become important for several industrial applications at elevated temperatures. 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

Coefficient of thermal expansion between 20 and ... °C (10^{-6} C^{-1}):

Temp. [°C]	100	200	300	400	500	600	700
Coefficient of thermal expansion (10^{-6} C^{-1})	**10.3**	11.2	11.7	11.6	11.7	11.8	11.8

Thermal conductivity [W/mK]:

Temp. [°C]	20	200	400	500
Thermal conductivity [W/mK]	22	23	27	27.5

Density

DENSITY [g/cm³]
At ambient temperature (20°C):
7.799

CONTINUOUS COOLING TRANSFORMATION (CCT) DIAGRAM

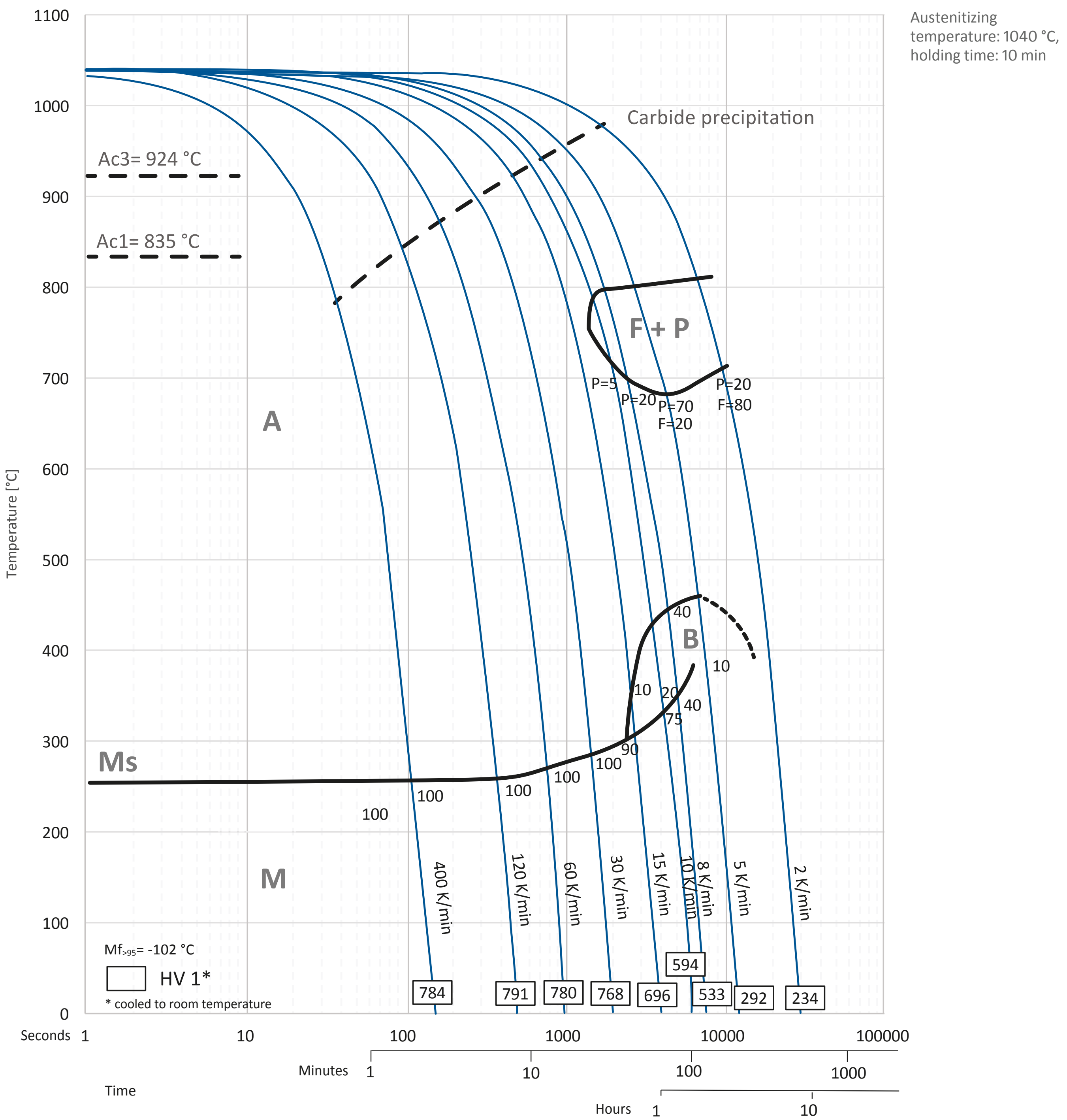


Fig. 8: Continuous Cooling Transformation (CCT) Diagram

DISCLAIMER