

Steel Elements Information

- CARBON (C)**
- Increases edge retention and raises tensile strength
 - Increases hardness and improves resistance to wear and abrasion
- CHROMIUM (Cr)**
- Increases hardness, tensile strength and toughness
 - Provides resistance to wear and corrosion
- COBALT (Co)**
- Increases strength and hardness and permits quenching in higher temperatures
 - Intensifies the individual effects of other elements in more complex steels
- COPPER (Cu)**
- Increases corrosion resistance
- MANGANESE (Mn)**
- Increases hardenability, wear resistance and tensile strength
 - De-oxidizes and de-gasifies to remove oxygen from molten metal
 - In larger quantities, increases hardness and brittleness

- MOLYBDENUM (Mo)**
- Increases strength, hardness, hardenability, and toughness
 - Improves machinability and resistance to corrosion
- NICKEL (Ni)**
- Adds strength and toughness
- PHOSPHOROUS (P)**
- Improves strength, machinability and hardness
 - Creates brittleness in high concentrations
- SILICON (Si)**
- Increases strength
 - De-oxidizes and de-gasifies to remove oxygen from molten metal
- SULPHUR (S)**
- Improves machinability when used in minute quantities
- TUNGSTEN (W)**
- Adds strength, toughness and improves hardenability
- VANADIUM (V)**
- Increases strength, wear resistance and increases toughness

Spydercollection.com

Steel Chart

STEEL	Carbon	Chromium	Cobalt	Copper	Manganese	Molybdenum	Nickel	Phosphorus	Silicon	Sulphur	Tungsten	Vanadium	HRC
0-1	0.85-1.00	0.40-0.60	-	-	1.00-1.40	-	0.30	-	0.50	-	-	0.30	57-62
W-1	0.70-1.50	0.15	-	-	0.10-0.40	0.10	0.20	-	0.10-0.40	-	0.50	0.10	57-64
A-2	0.95-1.05	4.75-5.50	-	-	1.00	0.90-1.40	0.30	-	0.50	-	-	0.15-0.50	57-62
D-2	1.40-1.60	11.00-13.00	-	-	0.60	0.70-1.20	0.30	-	0.60	-	-	1.10	57-61
M-2	0.95-1.05	3.75-4.50	-	-	0.15-0.40	4.75-6.50	0.30	-	0.20-0.45	-	5.00-6.75	2.25-2.75	60-65
W-2	0.85-1.50	0.15	-	-	0.10-0.40	0.10	0.20	-	0.10-0.40	-	0.15	0.15-0.35	57-64
L-6	0.65-0.75	0.60-1.20	-	-	0.25-0.80	0.50	1.25-2.00	-	0.50	-	-	0.20-0.30	57-62
1095	0.90-1.03	-	-	-	0.30-0.50	-	-	0.04	-	0.05	-	-	57-62
5160	0.56-0.64	0.70-0.90	-	-	0.75-1.00	-	-	0.035	0.15-0.30	-	-	-	57-60
E52100	0.98-1.10	1.30-1.60	-	-	0.25-0.45	-	-	0.025	0.15-0.30	0.025	-	-	57-62
420	0.15	12.00-14.00	-	-	1.00	-	-	0.04	1.00	0.03	-	-	52-56
420 MODIFIED	0.40-0.50	12.00-14.00	-	-	0.80	0.60	-	0.05	1.00	0.02	-	0.18	54-56
425 MODIFIED	0.40-0.54	13.50-15.00	-	-	0.50	0.60-1.00	-	0.035	0.80	0.03	-	0.10	56-60
440A	0.65-0.75	16.00-18.00	-	-	1.00	0.75	-	0.04	1.00	0.03	-	-	55-57
440B	0.75-0.95	16.00-18.00	-	-	1.00	0.75	-	0.04	1.00	0.03	-	-	57-59
440C	0.95-1.20	16.00-18.00	-	-	1.00	0.75	-	0.04	1.00	0.03	-	-	58-60
440XH	1.60	16.00	-	-	0.50	0.80	0.35	-	0.40	-	-	0.45	58-62
AUS-6	0.55-0.65	13.00-14.50	-	-	1.00	-	0.49	0.04	1.00	0.03	-	0.10-0.25	57-58
AUS-8	0.70-0.75	13.00-14.50	-	-	0.50	0.10-0.30	0.49	0.04	1.00	0.03	-	0.10-0.26	58-59
AUS-10	0.95-1.10	13.00-14.50	-	-	0.50	0.10-0.31	0.49	0.04	1.00	0.03	-	0.10-0.27	59-60
GIN-1*	0.90	15.50	-	-	0.60	0.30	-	0.02	0.37	0.03	-	-	58-60
ATS-34	1.05	14.00	-	-	0.40	4.00	-	0.03	0.35	0.02	-	-	59-61
154CM	1.05	14.00	-	-	0.50	4.00	-	-	0.30	-	-	-	59-61
ATS-85	1.00	14.00	0.40	0.20	0.50	0.60	-	-	0.40	-	-	-	60-62
VG-10	0.95-1.05	14.50-15.50	1.30-1.50	-	0.50	0.90-1.20	-	0.03	0.60	-	-	0.10-0.30	60-62
BG-42	1.15	14.50	-	-	0.50	4.00	-	-	0.30	-	-	1.20	61-63
MBS-26	0.85-1.00	13.00-15.00	-	-	0.30-0.60	0.15-0.25	-	0.04	0.65	0.01	-	-	57-59
MRS-30	1.12	14.00	-	-	0.50	0.60	-	-	1.00	-	-	0.25	59-61
CPM(T) 440V**	2.15	17.00	-	-	0.40	0.40	-	-	0.40	-	-	5.50	55-57
CPM 420V**	2.30	14.00	-	-	-	1.00	-	-	-	-	-	9.00	56-58
CPM 10V**	2.45	5.25	-	-	0.50	1.30	-	-	0.90	0.07	-	9.75	56-58
CPM 3V**	0.80	7.50	-	-	-	1.30	-	-	-	-	-	2.75	58-60
SANDVIK 120C	-	14.00-14.50	-	-	0.35	-	-	-	0.35	-	-	-	54-56
HITACHI SHIROGAMI 1	1.30	-	-	-	0.20	-	-	0.025	0.10	0.04	-	-	63-64
CRB-7	1.10	14.00	-	-	0.40	2.00	-	-	0.30	-	-	1.00	59-61
MVS-8	0.85	14.00	-	-	0.50	2.50	-	-	0.50	-	-	0.15	57-61
VASCOWEAR	1.12	7.75	-	-	0.30	1.60	-	-	1.20	-	1.10	2.40	59-61

*GIN-1 (Gingami 1) is the accurate manufacturer's reference name for this steel. GIN-1 is also known as G-2.

**The process used to manufacture particle metallurgy permits unusually high carbon and vanadium content.



Materials Descriptions

ABS is black thermosetting with high impact strength.

CARBON FIBER is a woven composite of graphite fibers in an epoxy resin and provides a light weight, high strength material.

CONCEALEX is a new advanced generation of thermoplastic, resistant to most chemicals, oils and solvents and is absolutely waterproof.

CORDURA is a strong woven nylon fabric used for sheaths.

G-10 is an epoxy-filled woven "E" glass composite reinforced with glass fiber that provides exceptional strength and resistance to fractures in extreme temperatures.

KRATON is a black thermoplastic rubber polymer used as a flexible inlay to enhance grip.

MICARTA is a composite of linen or paper fabric in an epoxy resin that provides light weight, durability and visual appeal.

SERMOLLAN is a durable rubberized plastic used for secure grip.

TITANIUM is a non-ferrous metal used for its high tensile strength, light weight and corrosion resistance.

Steel Production and Properties

The following provides a very brief overview of steel treatment and properties:

By definition, steel is a combination of iron and no more than 2% carbon. Steel is alloyed with various other elements that combine to produce special properties. Once a particular **alloy₁** combination (or steel type) is selected, specific procedures are used to maximize the unique qualities required for that steel to perform. Generally speaking, the process for converting a steel alloy into a premium knife steel is **heat treating₂**.

Heat treatment is the most important stage in the evolution of an alloy into a performance knife steel. The first step in the heat treatment process is to reach a **critical temperature₃**. This temperature is held for a specific amount of time (depending on the steel being hardened) and causes the steel to become **austenitized₄**. Heat treatment is one of many factors that determines the **grain size₅** of the steel (a fine grain structure is more desirable for knife blades because it improves edge retention and enhances blade finish).

Next, the steel is **quenched₆** to achieve its maximum level of **hardness₇**. At this point, the steel is too hard and brittle for practical use and thus **tempering₈** is of key importance in bringing the steel to its ideal hardness level (different knife steels perform best at different levels of hardness). Tempering also increases wear resistance and **toughness₉** properties. When tempering, it is important to understand the interaction between hardness and toughness. An increase in hardness is usually accompanied by an increase in **yield strength₁₀** and **tensile strength₁₁** and a decrease in **Impact Strength₁₂** and **ductility₁₃**. An increase in toughness is usually accompanied by the opposite effect (i.e. an increase in toughness and ductility and a decrease in yield strength and tensile strength). Therefore, high-impact knives such as swords or machetes would benefit from a softer blade (to avoid blade breakage), while low-impact knives such as pocket knives may benefit from a harder blade (to improve wear resistance). Once tempering is complete, the final hardness of the steel can be determined using a **Rockwell Test₁₄**.

For more detailed information on the above processes and properties, we recommend the following references that were used to compile this information: *Metallurgy Fundamentals* by D. A. Brandt (published by Goodheart-Willcox) and *Heat Treaters Guide* by P. M. Unterweiser (published by ASM).

1. Alloy - a material that is dissolved in another metal in a solid solution; a material that results when two or more elements combine in a solid solution. **2. Heat Treating** - heating and cooling metal to prescribed temperature and the limits for the purpose of changing the properties and behavior of the metal. **3. Critical Temperature** - the temperature at which steel changes its structure to austenite in preparation for hardening. **4. Austenitized** - the basic steel structure state in which an alloying is uniformly dissolved into iron. **5. Grain Size** - the physical size of the austenite grains **during** during austenizing. The actual size can vary due to thermal, time and forging considerations. **6. Quenched** - rapidly cooled from the critical temperature using water, oil, air, or other means. **7. Hardness** - the resistance of a steel to deformation or penetration analogous to strength. **8. Tempering** - reheating to a lower temperature after quenching for the purpose of slightly softening the steel, precipitating carbides, stress relieving. **9. Toughness** - the ability of a material to resist shock or impact. **10. Yield Strength** - the point at which a steel becomes permanently deformed; the point at which the linear relationship of stress to strain changes on a Stress/Strain curve. **11. Tensile Strength** - indicated by the force at which a material breaks due to stretching. **12. Impact Strength** - the ability of a material to resist cracking due to a sudden force. **13. Ductility** - the tendency of a material to stretch or plastically deform appreciably before fracturing. **14. Rockwell Test** - a measurement of steel hardness based on the depth of penetration of a small diamond cone pressed into the steel under a constant load.

