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D-2 | Heat Treating

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LATROBE SPECIALTY
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About D-2

D-2 is an air-hardened tool steel used in many industrial applications from slitters to dies.

Designed for hard use and corrosion resistance, D-2 has been used in the knife making community since it was first introduced. D-2 can take a beating and come back for more for years on end.

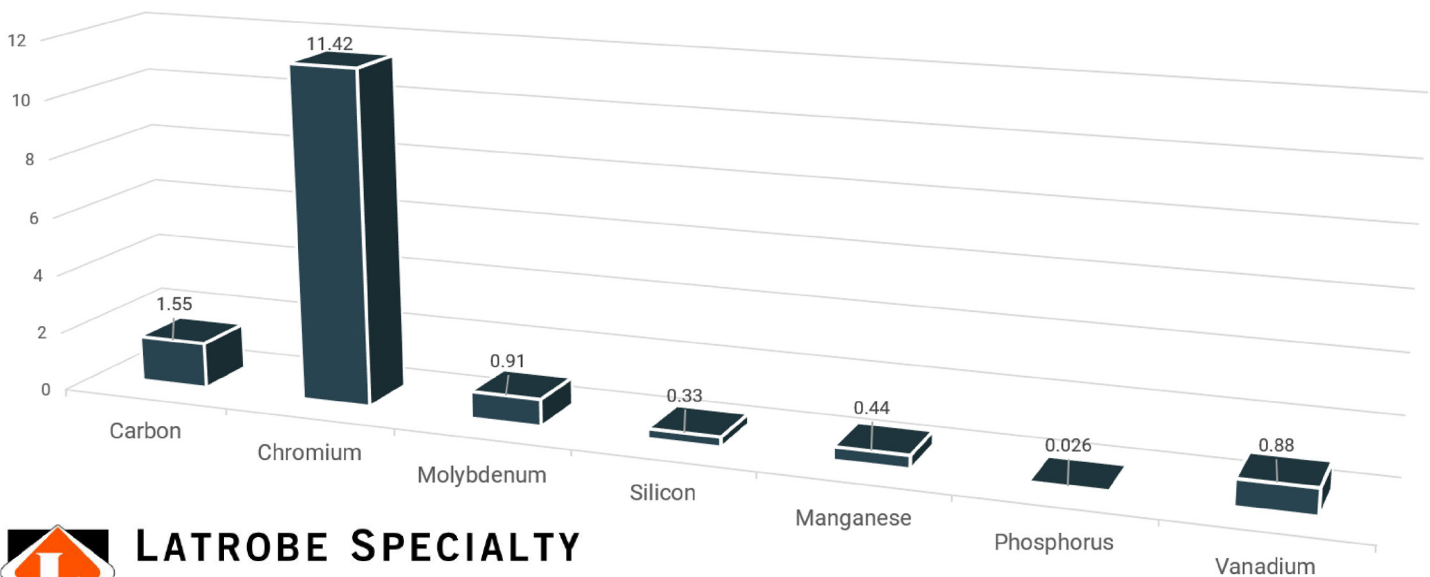
The high chromium and unique carbide structure lend itself to robust edges that take a tooth burr that just keeps cutting when other steels will have blunted ages ago.

When combined with a solid heat treat schedule and well-planned construction, a good knife made from D-2 in the right hands is almost literally bombproof.

If you are interested in D-2 but want a little oomph, check out our CPM D-2 as well; even though it has a higher price, it is well worth it for the bonuses you get from the powder metal processing.

Typical applications for LSS D2 tool steel include rolls, punches, dies for blanking, forming, trimming, and thread rolling, shear knives, food-processing knives, and gages.

Alloy Chemistry %

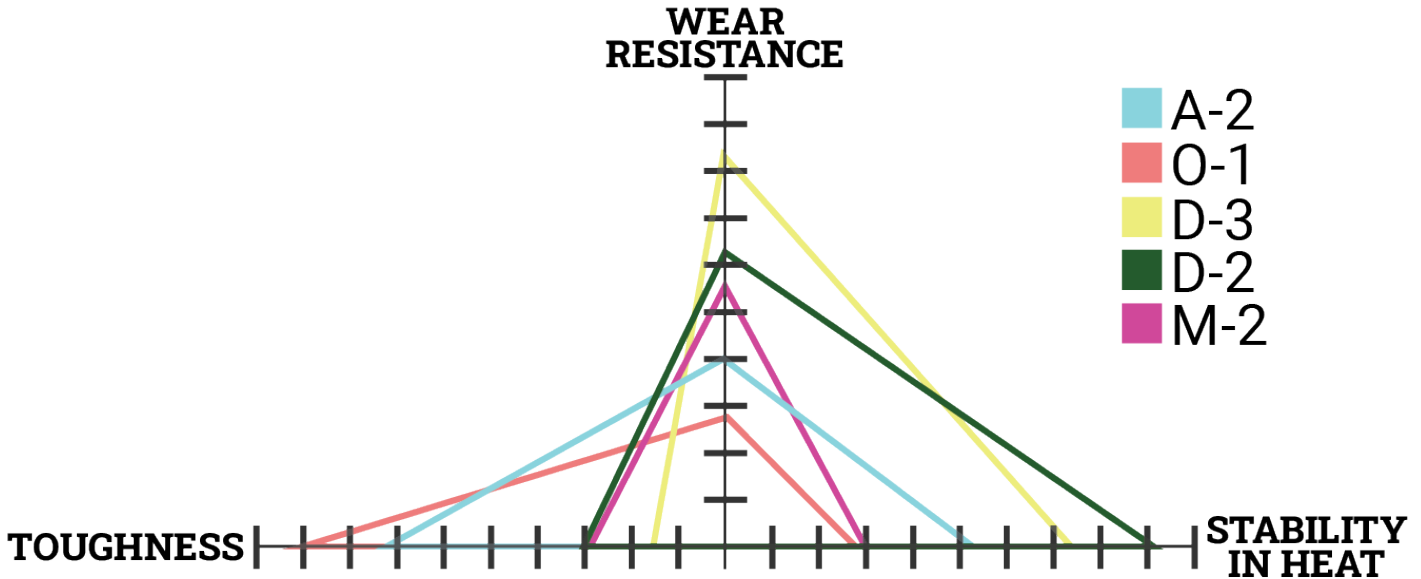


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About D-2

Blade Steel Comparagraph



Physical Properties

Elastic Modulus	30 X 10 ⁶ psi	(207 GPa W/m/°K)
Density	0.278 lbs./in ³	(7695 kg/m ³)

Thermal Conductivity

	W/m-°K	BTU-in/hr-ft ² -°F
at 68°F (20°C)	20	139





Coefficients of Thermal Expansion

	in/in/°F	mm/mm/°C
100-500°F (38 to 260°C)	5.71X10 ⁻⁶	10.3x10 ⁻⁶
100-800°F (38-427°C)	6.63X10 ⁻⁶	11.9X10 ⁻⁶
100-1000°F (38-538°C)	6.82X10 ⁻⁶	12.3X10 ⁻⁶
100-1200°F (38-649°C)	6.83X10 ⁻⁶	12.3X10 ⁻⁶
100-1500°F (38-815°C)	6.90X10 ⁻⁶	12.4X10 ⁻⁶



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Important - Before Treating

- Knives should be cleaned by washing with soapy water and then either placed into foil pouch or coated with high temperature anti-scale/decarburization compound prior to heat treat if not using Oxygen free heat treat equipment.
- Skipping stages such as pre-heating and equalizing or cryo will result in lower hardness, higher amounts of Retained Austenite (RA), impaired stain resistance or other issues. Ramp AFAP (as fast as possible) between preheating and austenizing temps.
- Clamping flat after quench during cryo or tempering recommended to avoid thermal shock induced warp.
- **Figures represent quenching under positive pressure with aluminum plates and compressed air to at or below 125°F / 50°C--alternative quenching methods may present lower hardness, high RA, or other issues.**



Pre-Heat/Equalizing	Pre-Heat/Equalizing	Austenizing Temperature	Expected RC (as quenched prior to cryo)
1,200°F / 650°C Hold 10-15 minutes	1,400°F / 760°C Hold 10-15 minutes	1,850°F / 1065°C Soak 30 minutes	61Rc (64 after Cryo)

Cyrogenic Treatment

- A cryogenic treatment is recommended to convert retained austenite, and can either be done before or after the first temper cycle.
- While liquid nitrogen is preferred, a sub zero bath with dry ice and kerosene will suffice for -100°F / -74°C.
- Submerge in sub-zero treatment 1 to 4 hours depending on thickness and number of blades.
- **A cryogenic treatment can be done immediately done after quench, but it is recommended blades be clamped flat to avoid thermal shock induced warp--cryo treatment should always be followed by a tempering cycle.**





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Tempering

- Once blade is quenched and near ambient temperature, blades should be tempered accordingly, the times suggested are to ensure even, consistent temperature.
- Figures supplied are as representative of industrial standards.
- **If using a small toaster oven or household kitchen oven for tempering, using a blade holding rack made from kiln furniture, a roasting tray lined with fine sand, or similar large object will help retain thermal mass to reduce wide swinging temperatures as the device fluctuates trying to maintain temperature.**
- **Note: Final hardness values vary based on initial as-quenched hardness and percentage of conversion to Martensite. Only reliable testing methods, e.g. calibrated Rockwell hardness tester, can provide actual hardness values--hardness calibrated files and chisels are relative testing methods and inaccurate for true hardness value reading.**
- Temper twice for 2hrs.



Temperature:	Hardness (2 hour x2 guideline):
300°F / 149°C	62
400°F / 204°C	61
500°F / 260°C	60
600°F / 316°C	59

- **Manufacturers warn against tempering at 800°F / 425°C and above as sensitization will result in reduction of toughness and corrosion resistance.**
- **The included Heat Treat Schedule on this page is formulated based upon Industry standards and data from ASM International, Crucible and other foundry spec sheets, and Kevin Cashen (independent researcher, ferroalloy metallurgist, and bladesmith of Matherton Forge).**





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Heat Treating Disclaimer

- Suggested heat treatment are based on the recommended specifications for use in ovens, high temp salts, and similarly, properly calibrated equipment; and in line with proper industrial standards for quenching. Deviation from industry standards for schedules, equipment, quenching mediums; and hardness testing equipment may result in varied results. The supplied information on this page is on a generalized scale with the above mentioned standards and methods, which is why soak times and similar aspects may vary in time length to include a margin for the available heat treating equipment and steel cross section.
- If you are unsure if you have the necessary means to heat treat on-site, we recommend professional heat treating services provided by Peters Heat Treat or Bos Heat treating; or industry specific services by knife material dealers such as TruGrit or Texas Knifemaker's Supply--check with suppliers to see if they offer HT services and ensure they follow industry standards.
- NJSB LLC is not liable or responsible if proper industry heat treating protocols are not applied; particularly and especially if sending to an independent heat treat provider if they do not follow the intended heat treat schedule or standards for that particular steel; or damage they cause while in their possession.

