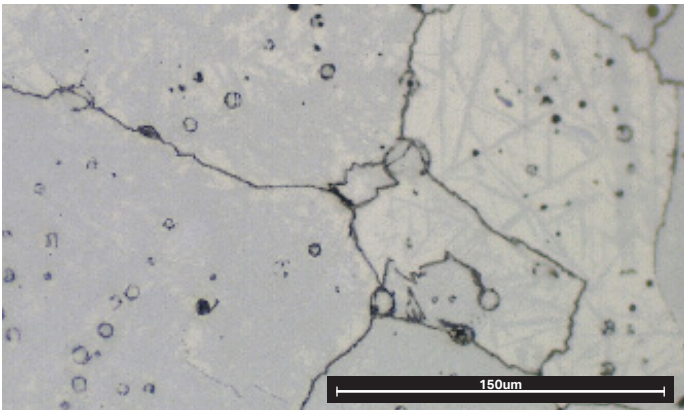
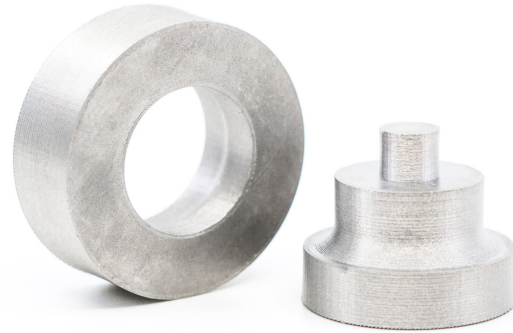


# A2

## TOOL STEEL

Other Designations: UNS T30102, DIN 1.2363 , X100CrMoV5, SKD12, BA2

A2 tool steel is a highly versatile air-hardening tool steel often regarded as a “universal” cold work steel. It offers a combination of good wear resistance (between O1 and D2) and toughness. Considered relatively easy to machine in the annealed condition, it has a high compression strength and good dimensional stability during hardening and tempering. It's used for a wide variety of cold-work tools, from forming and cutting equipment to high wear parts.



Composition	Weight%
Chromium	4.75-5.5
Molybdenum	0.9-1.4
Carbon	0.95-1.05
Manganese	0.4-1
Phosphorous	0.3 max
Vanadium	0.15-0.5
Silicon	0.1-0.5
Iron	bal

Physical Properties	Test	Markforged Heat-Treated <sup>1</sup>	Wrought Heat Treated
0.2% Compressive Yield strength [MPa]	ASTM E9	1170	—
Elastic Modulus [GPa]	ASTM E9	160	190
Hardness <sup>3</sup> [HRC]	ASTM E18	50	63
Relative Density <sup>4</sup> [%]	ASTM B923	94.5	100

### Heat Treatment

A2 tool steel can be heat-treated to increase hardness and durability. Markforged recommends heat-treating A2 tool steel to optimize material properties, though it can be used as-sintered.

- Heat A2 Tool Steel part in a standard (non vacuum) furnace to 970°C (1780°F) . Hold part at temperature for 30-45 minutes.
- Air quench part to below 65°C (150 °F).
- Double temper A2 Tool Steel part in a standard furnace. For each temper, heat part to 150-550°C<sup>3</sup> (302-1022°F) and temper for 2 hours, or 1 hour per inch of thickness. If double tempering, let part cool to room temperature between tempers.

- Markforged heat-treated A2 tool steel was heated to 970°C (1780°F) and single tempered at 200°C (392°F) for 30 minutes.
- Tempering temperature has a significant effect on final material properties. For higher hardness, temper at low temperatures. For higher toughness, temper at higher temperatures.
- As-sintered hardness can vary significantly based on furnace loading and ambient environment. Markforged recommends post-sinter heat treatment for maximum hardness and compression strength.
- Relative density for A2 assumes a density of 7.86 g/cm<sup>3</sup>.

These data represent typical values for Markforged A2 Tool Steel as-sintered. Markforged samples were printed with solid fill. Relative density and as-sintered hardness was tested in house. All other data were tested and confirmed by outside sources. These representative data were tested, measured, or calculated using standard methods and are subject to change without notice. Markforged makes no warranties of any kind, express or implied.