M2, M4, M42 versus 10V HSS

References:

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- Alan Lacer, http://westbaywoodturners.com/tutorial/ToolSteel.pdf
- AAW, https://www.gulfcoastwoodturners.org/wp-content/uploads/2017/03/Tool-Steels-in-Woodturning.ppt.pdf
- Wikipedia, https://en.wikipedia.org/wiki/Powder_metallurgy
- Vac Aero International, Inc., https://vacaero.com/information-resources/the-heat-treat-doctor/1173-tool-steel-carbides.html

Before you go out and buy the Cadillac of turning tools, think of this:

Sharpening

Aluminum Oxide grinding wheels are softer than Carbide particles found in turning tools.

The "white" wheels that came with your grinder are low quality aluminum oxide wheels. The "Pink" wheels, and some "blue" wheels, are also Aluminum Oxide. Norton and OneWay (among others) make excellent quality Aluminum Oxide grinding wheels. They still are not capable of forming an edge on carbides, and won't give you peak performance from your powder metal tools.

Grinding

The hard carbide particles from the hardening process/powdered metal make up of the HSS need to be sharpened with something harder than the carbide particles are such as CBN (Cubic Boran Nitride) wheels.

If they are not, the carbide particles are not able to be formed into a part of the edge. Instead of being abraded into a sharp edge, they are knocked out of the matrix resulting in an uneven cutting edge, and end up doing very little to help the tool hold a sharp edge longer.

This is why a lot of turners feel that powder metal tools don't initially get as sharp as M2 tools. They are usually not using an abrasive that will put an edge on the carbide particles.

Carbide Influence

tool steels are alloyed with different types of carbide forming elements (e.g. vanadium, tungsten, molybdenum and chromium) and in some alloys, cobalt.

The addition of alloying elements serves two basic purposes:

(a) to improve hardenability and

(b) to provide harder and thermally stable carbides.

Carbides contribute to strengthening of tool steels in two different ways:

- Carbides provide resistance to (abrasive) wear given that alloy carbides are significant harder than the matrix material;
- Carbides contribute to higher yield strengths by impeding the mobility of matrix dislocations.

The powder metallurgy press and sinter process generally consists of three basic steps: powder blending (pulverisation), die compaction, and sintering. Compaction is generally performed at room temperature, and the elevated-temperature process of sintering is usually conducted at atmospheric pressure and under carefully controlled atmosphere composition.

"powder metallurgy"

10V is made using a process called "powder metallurgy", where the final product contains very fine particles of carbides.

Other powder metal tool alloys commonly found in woodturning tools are M4, M42, 10V and 15V. The extra hard carbide particles are what make powdered metal tools hold an edge significantly longer than M2.

CBN Wheels

- CBN, (Diamond, and Ceramic for industrial applications) are harder than Carbide, and can form a sharp edge on powdered metal tools
- Sharpening with fine grit seems to make more of a difference in the quality of the cutting edge on 10V than it does on M2

But wait; there is MORE!

- Grinding wheels
- 8" x 1" x 5/8“ Norton Grinding Wheel aluminum oxide; **$69.95 each + $7.49 shipping** TIMES FOUR **used during lifetime = $309.76 + the dust from dressing the wheels can cause silicosis (carcinogenic)**
- **CBN wheel = $150 or buy two for $250** and will never get dull or wear out PLUS they sharpen sharper……

Steels

- **M2**, also called High Speed Steel, or HSS, is today's base standard for Woodturning tools
- **M2 HSS** is accurately heat treated according to precise specifications. Heat treating can be done poorly, or improperly. A low quality M2 tool might have the correct alloy composition, but not have the edge holding performance that it would have received from proper heat treating.

- **M42** Steel is also a conventional High Speed Steel like M2.
- **M42 has higher cobalt content than M2**, Some people feel that it holds an edge longer than M2.
- **10V** Steel is considered a Tool Steel. It is very tough and durable. Everything that is said about the precise alloy composition and accurate heat treating of M2 applies to 10V (A11) as well. The two metals are very different in composition, however.

Cryogenic tempering

- Cryogenic tempering takes place in a chamber, where the materials are gradually lowered in temperature. Shallow cryogenic tempering is performed at about -120ºF (-85ºC) for 10 hours or so, whereas deep cryogenic tempering takes the material below -300ºF (-185ºC) for more than 24 hours. The materials are then slowly raised to room temperature and usually annealed at about 300ºF (149ºC) for several hours. **Only deep cryogenic tempering has shown to give the greatest improvement in wear resistance.**

Increased wear life?

- Controlled experiments and industry experience have demonstrated that many materials benefit from this Cryogenic treatment. Increased wear life and better corrosion resistance, while at the same time maintaining or even improving toughness have been observed. However, few materials benefit more than tool steels. **Tool steels that are deep cryogenically treated will typically last more than 50 % longer than as quenched specimens.**

Although cryogenic tempering has been proven to help in industrial applications, the extra cost for woodturning tools may not be worth the added cost for the average woodturner