Aobo Steel
Tool steel supplier, Huangshi, China
sales@aobosteel.com

Spark Testing Tool Steel Grades and Chemistry

A spark test grinds a sample against a high speed wheel until the chips come off burning, and each grade of tool steel burns with its own burst, stream, colour and shape. The tables below give the set-up that makes a reading repeatable, and the spark signature of each alloying element, so a bar without papers can be compared against a known sample before it is cut.

Reference only. This is a reference summary of published shop practice and it is not a specification of ours or a test procedure of ours. Spark appearance depends on the wheel, the light and the experience of the tester, and a reading is a comparison against a known sample rather than a measurement. Release of material for production is decided by the material test certificate. Final specification is confirmed on the job.

What the test can and cannot decide

The set-up that makes the reading repeatable

Set-up point	What the test calls for	Why it matters to the reading
Wheel speed	A high-speed grinder running 10,000 to 20,000 rpm	The spark is the chip burning in air. Below that speed the chips come off too cool to burn in a readable stream.
Wheel size and grit	An abrasive wheel 2 to 3 in. (50.8 to 76.2 mm) in diameter, approximately 40 grit	A small wheel and a coarse grit take a light cut that throws a clean stream instead of heating the sample.
Wheel condition	Dress the wheel so it is not loaded with grit from earlier grinding	Loaded grit cuts cooler and throws sparks that do not belong to the steel in front of you.
Contact pressure	Do not use pressure that slows the abrasive wheel	A wheel dragged down to a lower speed burns the steel differently and moves the burst pattern away from the reference sample.
Sample surface	Do not test a decarburized or scaled surface layer	The surface layer is not the steel that was ordered. A decarburized skin sparks like a lower-carbon material than the bar underneath it.
Light	Diffused light, a room that is neither brightly lit nor dark	Colour is half the reading and it is read against the surroundings. The same burst reads differently in a bright bay and in a dark corner.
Practice samples	Build a set of samples identified by grade and hardness and spark them daily	The bright and dark portions of a burst are learned by eye. A tester who has not looked at a known sample recently is reading the comparison from memory.

The practice recommended for spark testing, from the spark testing section of Tool and Die Making Troubleshooter. Reference samples are as identified on the samples themselves.

Carbon and hardness in the burst

What each alloying element does to the spark

Element	What it does to the spark	What the tester is reading
Carbon	The higher the carbon, the more plentiful and the more complicated the burst	Burst intensity is the carbon reading. Hardened steel throws a longer and denser pattern than the same grade in the annealed condition.
Silicon	Suppresses the carbon burst and burns dark red	A suppressed burst over a dark red stream points at silicon as a deoxidizer rather than at a low-carbon steel.
Chromium	Suppresses the spark stream and burns bright orange	The orange colour is the carbides. Chromium raises hardenability and wear resistance and it raises the hardening temperature, which is why the high-chromium families read unlike carbon steel.
Nickel	Suppresses the stream and the burst slightly and ends the stream with a forked tongue	A forked tongue at the end of an otherwise quiet stream is the nickel signature.
Tungsten	Suppresses the effects of the other elements and burns with a bright orange tongue pattern	Tungsten overrides the rest of the reading, so a high-speed steel sparks in a pattern set mainly by its tungsten content.
Vanadium	Brightens the spark stream as a whole	Vanadium is read as overall brightness rather than as a separate burst or colour.
Molybdenum	Produces a characteristic spear point	The spear point is the most useful single signature in the tool steel groups, because the hot work and high-speed grades are separated by their molybdenum content.
Manganese	Has a minimal effect where the steel carries moderate or large amounts of other alloys	Manganese is a deoxidizer and a hardenability addition, and it does not decide the reading in an alloyed tool steel.

The spark signature of each alloying element, from the spark testing section of Tool and Die Making Troubleshooter, itself drawn from Bethlehem Steel and Carpenter Technology spark charts.

Where the test stops and the certificate starts

Where to go next

Aobo Steel, tool steel supplier

Aobo Steel supplies tool steel to distributors and mold, tool and die shops, including D2, D3, DC53, A2, O1, H13, H11, H10, H21, S7, M2, M42, L6, P20 and 420 and 440C stainless. Forged or hot rolled, annealed or pre-hardened, cut to your sizes, with test certificates.

Source, Tool and Die Making Troubleshooter, R. M. Leed, Society of Manufacturing Engineers, 2003.

CONTACT

EMAIL
sales@aobosteel.com
WHATSAPP
+86 180 6294 5370
WEB
aobosteel.com

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