Matrix High-Speed Steels

Economical Alternative to Powders

If fracturing, chipping and microchipping plague your tooling, consider using a new breed of tool steel.

BY TOM SCHADE

Applications for Matrix High-Speed Steels

Applications	MDS1	MDS3	MDS7	MDS9
Punch	●	●	●	●
Trimming die		●		●
Bending/drawing die	●	●	●	●
Shear blades	●			
Blanking die		●	●	●
Slitter knife		●	●	●
Roll		●	●	●
Woodwork knife	●	●	●	
Heading die		●	●	
Rolling die		●	●	●
Warm-forming die	●			

Powder metallurgy offers significant advantages over traditionally melted cold-work and high-speed steels. The ability to produce highly alloyed steels free of segregation, with uniform grain structure and carbide distribution, allows powdered-steel producers to make claims about their steels' high performance. If your problems revolve around pure abrasive wear, many of these claims prove true.

Looking Beyond Abrasive Wear

In the Japanese tooling industry, it has long been accepted that abrasive wear is not always the cause of premature tool failure. Often, fracturing, chipping and microchipping—popping of individual or groups of carbides from a cutting surface—are the culprits. Japanese end-users sought a lower-cost material that could address all toughness and fatigue problems, so the Japanese specialty-steel industry searched for a class of wrought alloys to do just that.

The research efforts of Nachi-Fujikoshi Corp, Daido Steel Ltd and others resulted in a new series of matrix high-speed steels. As is common in Japan, these steels are not classified by AISI or JIS standards. Each producer markets its variation under a trade name. Nachi has the MDS series, MDS1, MDS3, MDS7 (matrix high-speed) and MDS9 (high-toughness cold-work). Daido has MH85, MH88 (matrix high-

Tom Schade is vice president of International Mold Steel, Florence, KY; tel. 800/625-6653; www.imsteel.com.

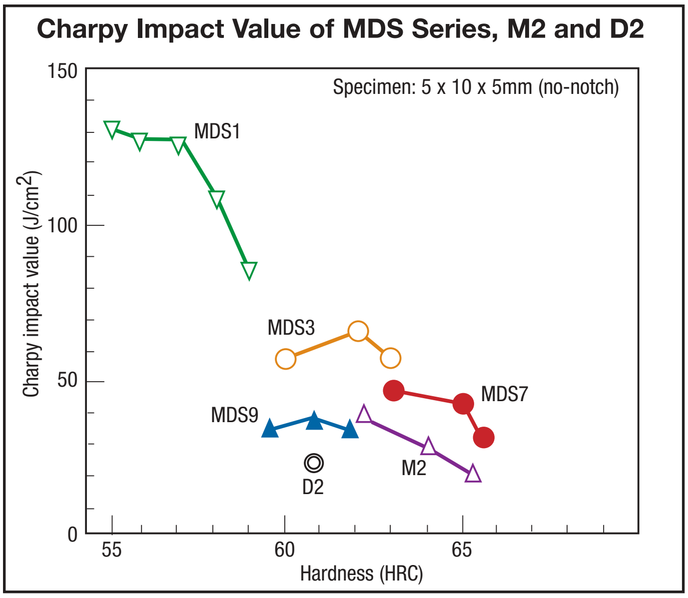

Fig. 1

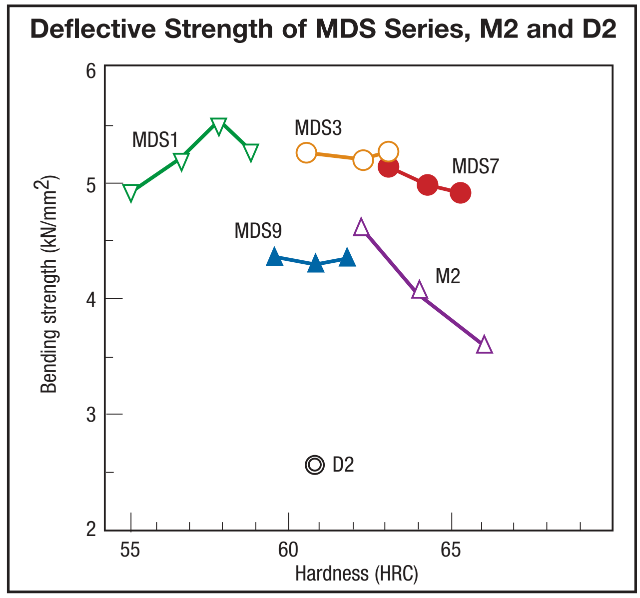

Fig. 2

speed) and DC53 (high-toughness cold-work die steel).

Carbide Size and Quantity Limit Effectiveness

Consider D2, a low-cost high-hardenability cold-work die steel. Large carbide particles and lack of toughness can limit the life of tools made from D2 in certain applications, and the large carbide particles also compromise machinability and grindability. In the 1980s, Japanese researchers realized that by lowering alloying elements and increased hot-working grain refinement, they could produce super-tough fine-grained cold-work die steels with advantages over D2. Thirty-percent improvement in machinability and grindability, improvements in impact and fatigue strength, and higher hardenability at high draw temperatures caused the Japanese tool industry to gravitate to these steels throughout the 1990s.

The Japanese specialty-steel industry then shifted its focus to overcoming the inherent low-fracture resistance of high-speed and powdered steels. The premise behind development of matrix high-speed steels: Carbides were the problem, not the solution. Developers already had shown with the high-toughness cold-work materials that reducing the size and quantity of carbides had

Table 1—Heattreatment Characteristics of MDS Series

Grade	Heattreatment temp. (C)		Standard hardness (HRC)
	Austenitizing	Tempering	
MDS1	1100-1150	560-640	56-58
MDS3	1080-1160	540-600	60-64
MDS7	1100-1180	540-600	62-66
MDS9 DC53	1020-1050	180-200 500-560	58-62 60-64

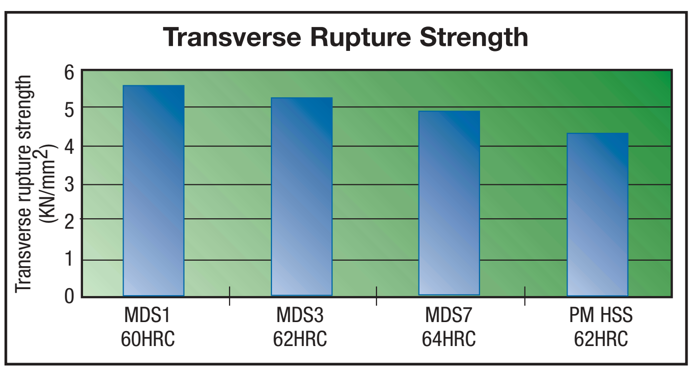

Fig. 3

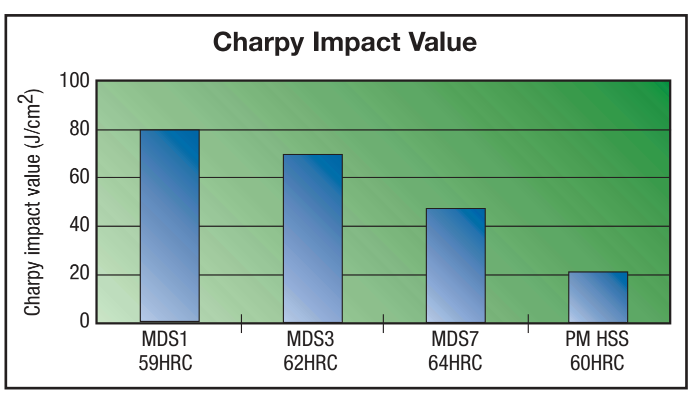

Fig. 4

benefits. With matrix high-speed steels, alloy elements are resubjected to a solid-solution treatment with a base (matrix), reducing the quantity of carbides. The end result offers high toughness and fracture resistance. Additional benefits include improved machinability and grindability. The trade off is reduced abrasive wear when compared to M2 or powdered steels.

Characteristics Defined

Toughness—Matrix high-speed tool steel exhibits high toughness and fracture resistance due to the special characteristics of its microstructure. Fig. 1 shows the Charpy impact value of the MDS series and Fig. 2 shows its deflective strength. When the Charpy impact value is compared at the same hardness, the value is higher for matrix high-speed steel than for M2 or D2. The same can be said for deflective strength. Figs. 3 and 4 show similar results when the matrix formula is compared to high-vanadium (10) powdered high-speed steel. This underscores the retention of the matrix steel's wear resistance and improved fracture resistance.

Machinability—Benefits due to fine grain structure and reduced carbides in matrix high-speed steels include improved machinability and grinding after heattreatment. Fig. 5 compares the grinding ratio (test-piece weight reduction divided by grinding-wheel weight reduction) as the indicator of grindability—a higher ratio indicates improved grindability. Reduced machining and grinding costs significantly reduce tool costs.

Heattreatment—Matrix high-speed steels are less sensitive than other high-speed steels to the slower cooling rate of vacuum heattreat furnaces. For example, the center hardness of an M2 100-mm bar loses three points of HRC as a result of slower vacuum-furnace cooling. Matrix high-speed steels do not lose HRC points. Table 1 shows austenitizing and temper temperature ranges as well as expected hardness ranges for MDS steels

Wear Resistance—Cold-work die steels offer a wide hardness range, extending from HRC 58 to HRC 65. Matrix high-speed formulations contain steels with differing wear-resistance levels. For example, the hardness for one is HRC 58, and HRC 62-64 for another. These levels are controlled by the quantity of the matrix. The results of this control can be seen in Fig. 6, where a lower wear ratio indicates superior wear resistance. Fig. 7 compares abrasive wear resistance to high-vanadium (10) powdered-metal high-speed steel.. **MF**

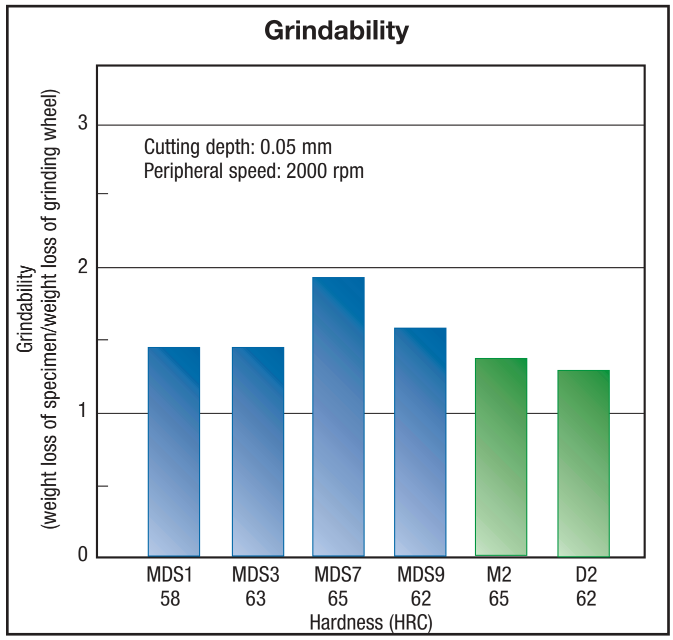

Fig. 5

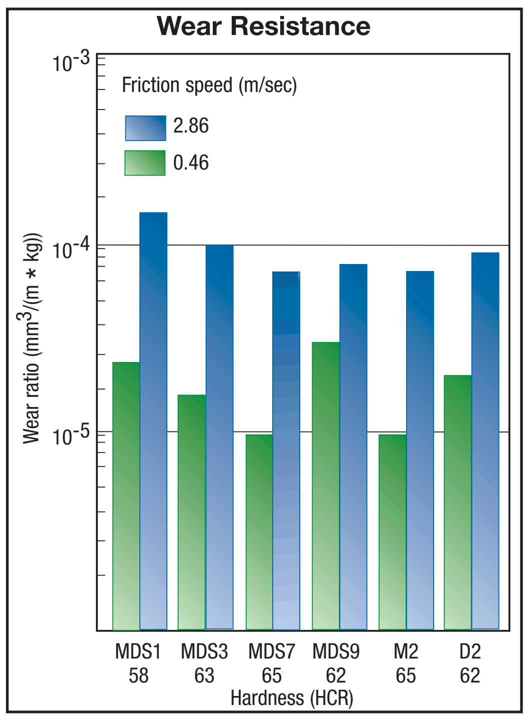

Fig. 6

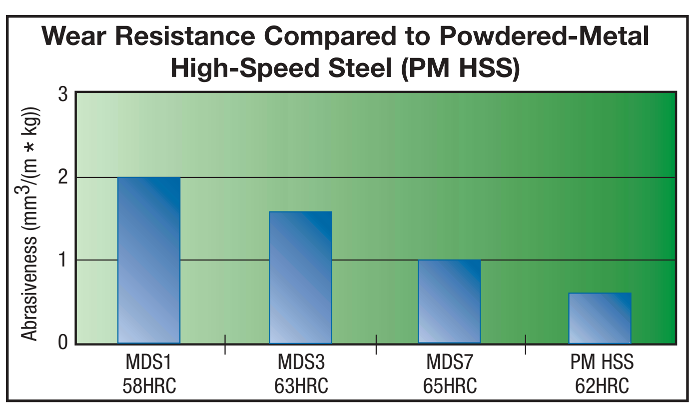

Fig. 7