

Peter Beyer

An idea gains acceptance

Hybrid technology for dressing systems



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Hybrid technology for dressing systems

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Dressing tools based on metal-ceramic matrix systems and embedded, suitable diamond crystal types combine free-cutting structures of high porosity with significant wear resistance.

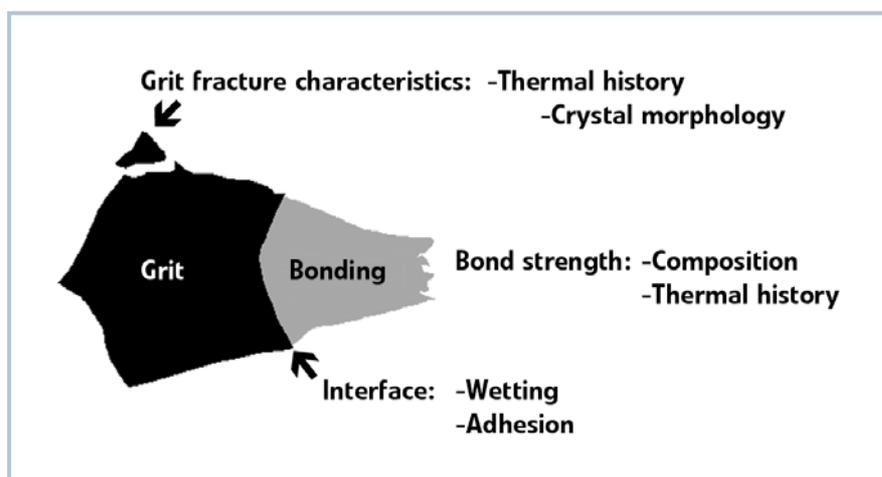
BY PETER BEYER

→ The sector of dressing tools has been characterised over decades by approaches in bonding technology featuring low levels of innovation. Essential process improvements were achieved primarily via optimised machines and dressing spindles combined with suitable parameters, and less via advances in the dressing tool itself. The established designs for tools including their innate advantages and disadvantages were only marginally modified.

The current state of technology is based on non-porous, sintered diamond dressers that have a disadvantage inherent in the system: surface topographies are created on the grinding tool that during grinding exhibit running-in behaviour according to the surface roughness of the processed component. Single-layered dressing tools are also commonly used. Process stability and economy is however limited by non-constant grit protrusion and only one useable grit layer. In addition, profiled dressing tools with diamond-like reinforcements have established themselves in a steel matrix that are even more unfavourably in terms of grinding wheel structure.

New technological approaches for porous dressing tools

For the development of new systems that expand upon existing concepts and that are intended to avoid such disadvantages,



1 Parameters for optimisation of grit retention forces in a porous dressing tool matrix

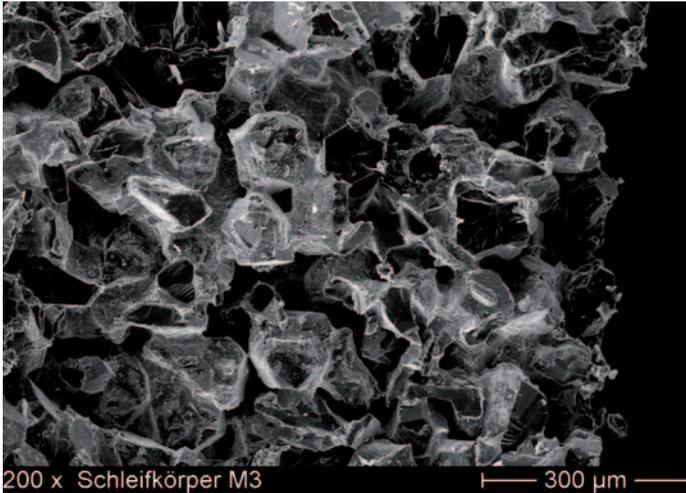
the R&D department of Meister Abrasives has entered the following requirements into a specifications list:

- a free-cutting system, ideally with self-sharpening mode, analogue to vitrified highly porous bondings,
- optimised grit retention forces,
- very good wear resistance,
- multi-layer systems, avoidance of short tool life of galvanized tools.

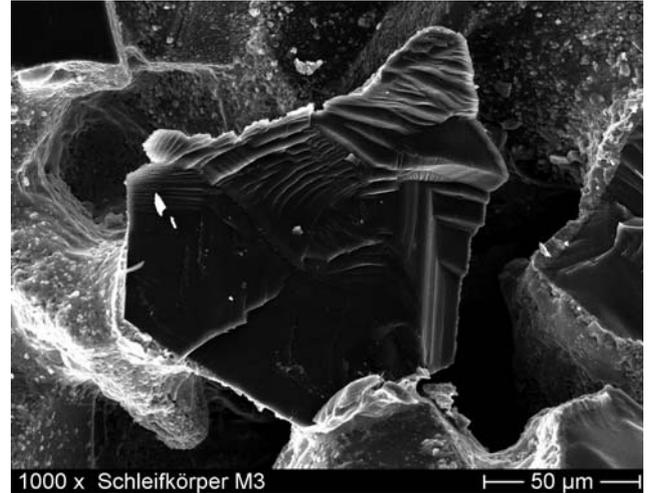
New technological approaches have only been recently developed through an innovative concept for production of porous dressing tools [1]. Introduced initially based on ceramic bonding technology as vDD tools (vitrified Diamond Dressers), this development has been consistently continued, resulting in a new type of bonding. A hybrid technology now unites the benefits of a porous matrix with signifi-

cantly improved wear resistance. In the meantime these tools have established themselves on the market as so-called hDD dressers (hybrid Diamond Dressers).

The non-porous, dense structure of a sintered metal-bonded dressing tool has reduced free-cutting properties due to its lower grit protrusion. The dressed grinding tool topography can therefore become impermissible smooth or dulled again. An open-pore vitrified structure on the other hand offers the potential for free-cutting but has disadvantages with wear resistance; this can be offset though by establishing a self-sharpening effect that maintains wear and cutting properties (dressing properties in this case). Due to a higher process stability, in this case greater wear may even be advantageous. Established applications for this, as outlined in previous publications,



2 Cross-section through an hDD structure shows the porosity of the hybrid matrix



3 Breakage of an hDD structure is usually combined with splintering of the diamond grit but not with delaminations to the matrix/grit interface

are still being used in series today [1]. vDD dressing tools are limited by reduced profile stability and wear resistance, mainly for the profiling of grinding tools with larger diameters.

Free-cutting structures can only be realised via a porous structure, analogue to the concept already implemented with vDD tools. Increasing wear consistency with porous ceramic structures comes up against system-inherent limits though. An alternative approach is therefore the use of metal-ceramic matrix systems. Fig. 1 shows the variables involved in optimisation. Selecting a suitable diamond crystal type and a corresponding size is decisive for the conditioning properties. The following parameters must be considered:

- cutting and wear behaviour compared to conditioned tool,
- crystal topology and interaction with the hybrid bonding,
- thermal stability due to the production process.

In order to significantly increase wear resistance, the intrinsic properties of the bonding matrix must be optimised as well as the interface between matrix and diamond grit with regard to adhesion properties. The following must be observed:

- wetting behaviour of the hybrid bonding on the diamond grit as a basis for establishing a bonding bridge,
- chemical reactivity of the diamond and bonding matrix,
- avoiding oxidation and re-graphitising of the diamond grain,

- avoiding the formation of brittle carbide phases,
- achieving a porous structure.

It is commonly known that diamond rapidly reacts with carbide formers such as Fe, Co, Ni, Al, Si or B [2, 3]. This offers potential for chemical bonding but increases the risk of formation of brittle aluminium carbides or silicides [4]. Additionally the manufacturing technology of vitrified structures for porous systems is not transferable to metal-hybrid-systems.

A process-oriented innovation however enables this combination while main-

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taining the specific positive properties. The resulting porous structure is shown exemplarily in Fig. 2. In the process the level of porosity, hardness of dressing tool, grit size and concentration can be tailored in a wide range. The achievable grit retention forces are shown in Fig. 3. The fracture surface shows no delamination on the interface between diamond grit and matrix, indeed the diamond grit fractures itself.

The hDD tools are used today in series processes as dressing cups on small turbines or as dressing wheels with interior

or exterior diamond layers in diverse variants. In each case the optimal customer-specific solution is focused upon, and this can be very finely adjusted. Applications for conditioning range from CBN internal or external profile grinding to Ceralox internal grinding. Three representative applications are intended to outline the spectrum for use of hDD tools.

hDD technology proves dependable across a wide range of applications

The first application concerns the dressing of internal grinding wheels with a dressing cup (Fig. 4). The parameters for this are:

- Application: Mini lash adjuster, Voumard machine,
- Grinding tool: Meister HPB CBN IG CB22-230-C175-V*,
- Dressing tool: Meister hybrid Diamond Dresser, DC D42-170-C150-H*.

Compared to a metal-bonded dresser, an hDD tool from Meister Abrasives achieves the following results (hDD/metal-bonded):

- dressing interval: 160/120,
- sharpening interval of dressing tool: self-sharpening/weekly (with 3-shift operation),
- Service life: 60000 cycles/9000 cycles (not process-secure, dulling of CBN wheel),
- geometry (conicity) on workpiece: < 1 µm/to 5 µm.

Improvements in geometry and finish quality were achieved with increased cutting performance of the grinding tool.



4 Conical dressing cup in hDD technology with porous structure

5 Dressing of exterior grinding wheels with the hDD dressing tool DD120x12x40 X=5 W=2 D42-426-175-H* cut process time by 30 per cent

In a second hDD application, external grinding wheels were dressed according to the following parameters:

- application: camshaft grinding with a Studer S32,
- grinding tool: 1A1 300x26x127 X=5 CB112-107-125-V*,
- dressing tool: DD120x12x40 X=5 W=2 D42-426-175-H*.

The following results were achieved:

- dressing interval: 150,
- finish quality Rz: 3 to 3.5 µm,
- cycle time: shortened by 30 per cent.

A third application is the dressing of Ceralox bore grinding wheels with the following key parameters and results:

- application: bore grinding, diameter dressing with an Emag,
- grinding tool: IS 25.5x6x8 530A-100X-I-10-155-V302T-3 Ceralox,
- dressing tool: DD 250x28x184 X=3 U=2 D42-426-150-H*,
- dressing interval: plus 50 per cent, no running-in behaviour following dressing.

Summary

The current generation of hDD dressing tools combines porous structures with high levels of wear resistance. Hybrid bonding means that conditioning/resharpening of dressers is not necessary, a process that is often mandatory with metal-bonded tools. Simultaneously, profile trueness of dressers can be relied upon, in turn significantly reducing the cost-intensive interruption of processing as a result of replacing/processing of dressing tools.

- 6 Use of the hDD tool DD 250x28x184 X=3 U=2 D42-426-150-H* increased dressing intervals for Ceralox bore grinding wheels by 50 per cent



During applications it is also possible to optimise the process chain right up to the workpiece. As such, geometric and surface properties can be implemented in a process-safe way with distinctly tighter tolerances. It is usually even possible to increase machining efficiency in the grinding process.

The number of series applications with hDD tools is growing strongly, as is the initial equipping of machines with such tools, and the technology in its second, slightly modified generation enjoys a wide degree of acceptance. If successfully implemented wear resistance and cutting performance are considered, the question could be raised about analogue systems for grinding processes. The grinding tool line called CERAMET has made many special applications for processing brittle materials possible, whether for ceramic implants, photovoltaic special materials or glass-ceramic precision components. The new generation of dressing and grinding tools gives users the possibility to increase pro-

ductivity for high performance grinding processes. Adaptation to further grinding technology applications is in development. ■

REFERENCES

- 1 Beyer, P.: Die vDD-Technologie für Diamant-Abrichtwerkzeuge in keramischer Bindung. In: IDR 1(2005)32, pages 39-41
- 2 Gardinier, C. F.: Physical Properties of Superabrasives. In: Am. Ceram. Soc. Bull. 6(1988)67, pages 1006-1009
- 3 Wedlake, R. J.: Diamond Synthesis. In: IDR 6(1977)11, page 196
- 4 Beyer, P.: Verstärkung von AL-Bauteilen durch lokale In-Situ Synthese von Al_2O_3/Ti_xAl_y -Verbunden im Squeeze Casting. VDI-Verlag 643(2002)

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