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DIAMOND SHEET - A NEW DIAMOND TOOL MATERIAL

Charles R. Mackey
Scomac Inc. President
LeRoy, New York

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DIAMOND SHEET is termed a diamond tool material because it is not a cutting tool, but rather a new material from which a variety of different tools may be fabricated. In appearance and properties, it resembles a sheet of copper alloy with diamond abrasive dispersed throughout it. It is capable of being cut, formed, and joined by conventional methods, and subsequently used for cutting as a metal bonded diamond tool.

ABRASIVE

DIAMOND SHEET is normally made with industrial diamond as the abrasive material. If materials or cutting conditions require, other types of abrasive may be used. Diamond sizes range from 100/120 screen size (149 - 125 microns) for coarse cutting operations, to single digit micron sizes for fine polishing. Work is being done on extending the range of coarse sizes, and some 60/80 screen size (250 - 177 microns) has been made experimentally. Diamond contents up to as high as 100 concentration (approximately 25 volume percent) can be manufactured.

SIZES

The current available size range of DIAMOND SHEET is .005 to .030 inch (.127 - .762 mm) for thickness, 3 inch (76.2 mm) maximum width, and 10 inch (254 mm) maximum length. The width and length maximums will probably be expanded in the future. Widths up to 4.5 inches (114.3 mm) and lengths up to 24 inches (609.6 mm) have been made experimentally.

MATRIX

The metal matrix in DIAMOND SHEET is a medium hard copper alloy which has performed well in most applications. This alloy has the capability of being made harder or softer if specific cutting conditions require it. Other alloys have also been used including a precipitation hardened aluminum alloy with very free cutting characteristics.

The standard copper alloy matrix provides cutting charact-

eristics very similar to that of a conventional molded copper alloy diamond tool. Because of the complete densification and homogeneous microstructure in DIAMOND SHEET, its cutting life is normally significantly improved. On a direct comparison basis, some tools made with DIAMOND SHEET have removed almost four times as much material as conventional molded tools of similar composition.

FABRICATION

The flexibility of DIAMOND SHEET allows it to be fabricated into a variety of products. Sections may be easily cut from pieces up to .020 in. (.508 mm) thick with paper cutting tools such as scissors and paper punches. Thicker sections may be cut and formed with hand metal working tools. Die cutting may be done on all thicknesses. Brazing, soldering, and organic abrasives may be used for joining.

SAWING

One of the most outstanding uses for DIAMOND SHEET, and the reason it was originally developed, is for thin cutting and slicing tools. Very close dimensional control can be maintained on the thickness, and tools are easily cut or blanked to shape.

For wafering applications, DIAMOND SHEET is a possible saw material for multiple blade saw cutting. Some limited tests made using solid strips of sheet showed it to be very free cutting with a good surface finish as compared to electroplated diamond and loose abrasive techniques. Tests have been limited because the sheet does not have sufficient strength to withstand the normal tensioning operation. Work is being done to join DIAMOND SHEET to a high strength alloy backing to overcome this problem. With I.D. and band saw blades, the possibility exists of replacing the present electroplated coating with DIAMOND SHEET segments.

The preceding applications could be accomplished by wrapping or folding DIAMOND SHEET strips over the blade cutting edge. A greater advantage can be obtained by butting or inseting the sheet on the edge. By this method, the cutting edge relief could be controlled and could be made less than the one particle width required for electroplated or loose abrasive tools. This would allow smaller kerf losses with existing blade backings, or thicker backings with less possibility of distortion using existing abrasive widths.

Circular saw blades blanked from DIAMOND SHEET have proven to be very effective in dicing and slotting operations. An economical method of using such saws is to have a saw mechanism capable of using a range of blade diameters, and utilize a set of increment flanges. A blade may then be set up with a large

flange, used until rim exposure is too small, then set up with the next smaller set of flanges for further use.

SURFACING TOOLS

Surfacing tools such as laps, bevelers, hones, etc. can be made by cutting full sections, segments, strips, or pellets of DIAMOND SHEET and attaching them to a backing. Such tools are ideally suited to prototype and short run production items. Because of their long cutting life, such tools can also be expected to compete favorably in normal production situations.

For wafering applications, laps virtually any diameter can be constructed for dimensioning and removing surface defects in wafers. The cutting characteristics of DIAMOND SHEET can provide rapid material removal and good uniform finishes while eliminating costly and machine damaging loose abrasives.

Surfacing tools with simple or compound curves can be formed by using male/female forms to mold and hold the DIAMOND SHEET as it is attached to a backing.

RING TYPE TOOLS

Tools such as core drills, ring cutters, and blanchard type wheels can be made by forming DIAMOND SHEET around a mandrel of the proper size, and attaching it to an appropriate backing.

Core drills as small as 3/16 in have been formed from sheet .020 in. thick. Small diameter core drills have been used successfully with only a single layer of sheet and an open butt joint. Larger single layer drills require a soldered or brazed joint to prevent flaring. In use, formed core drill sections are soldered to a mandrel or held directly in a collet.

Tools for surfacing operations such as ring cutters and blanchard wheels are formed using two or more layers of DIAMOND SHEET which are soldered or brazed together while being formed. The ring thus formed is mounted in a reusable backing plate.

Tools of this type are inexpensive and due to their thin walls, well suited to high speed, high unit pressure operations. On some very hard materials, DIAMOND SHEET tools have been the only economical method of material removal.

The examples of tools which can be made with DIAMOND SHEET represent only the most obvious examples of what can be done with it. The listing does not include items which are so mundane as to be overlooked such as files, or simply used loose as sandpaper for the hand finishing operations. On the other extreme are applications which are not normally associated with abrasive tools such as bearing surfaces (diamond to diamond) and wear resistant surfaces.