Data Storage Applications-TMR/GMR

Friable Polycrystalline Diamond

Friable Polycrystalline Diamond Slurries

The friability of polycrystalline diamond is one of a features which makes polycrystalline diamond such an excellent fine abrasive for lapping and polishing. Essentially, the polycrystalline diamond has many small crystallite cutting surfaces fused together to make a larger diamond particle. As the grinding, lapping and polishing occurs, these small crystallites will cleave and expose new and sharper cutting edges. The result is that polycrystalline diamond is a self sharpening abrasives which produces improved surface finishes having higher cut rates.

The primary advantages of polycrystalline diamond are:

- Higher cutting removal rates (self-sharpening abrasive)
- Very uniform surface finish
- More uniform particle size distribution
- Harder/ tougher particles
- Blocky shaped particles
- Hexagonal microcrystallites (equally hard in all directions)
- Extremely rough surface (more cutting points)
- Surface area 300% greater than monocrystalline diamond
- No abrasion-resistant directionality (abrasion independent of particle orientation)

Comminution Grinding Theory

Polycrystalline diamond abrasives are manufactured at very high pressures and temperatures. This is accomplished by a very carefully controlled explosion process. The resulting product is then sent to a crusher for productivity the required particle size distributions.

The crushing or grinding operation for polycrystalline diamond has a very significant effect on the friability of the diamond particles. For example, high energy crushing of a given lot will have a higher yield of fine particles as compared to low energy of crushing. The energy of crushing also affects the surface grinding features of the polycrystalline diamond. Thus, although polycrystalline diamond produces better overall surface finishes as compared to monocrystalline diamond, it can also have a wide performance range depending upon how it was crushed.

"Improve surface finish, reduce PTR /ALR recessions and minimize embedded diamond"

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Comminution Grinding Theory (conti.)

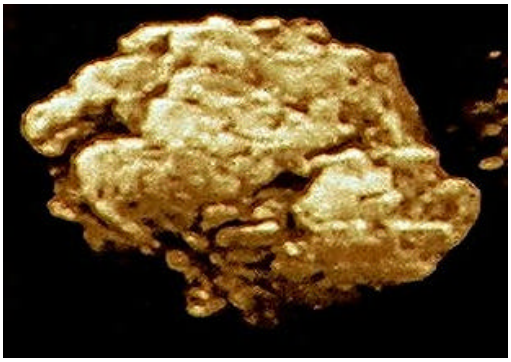
With the very precise diamond lapping requirements for the data storage industry, variability in the crushing parameters can dramatically affect lapping consistency from lot to lot. The problem is that until now the diamond slurry manufacturers have not had any control over the manufacturing and crushing operation for the diamond which they purchase.

Pace Technologies has recognized that the major variability in the performance of polycrystalline diamond has been the crushing variable and has worked closely to develop the specific guidelines for proper crushing of fine grit polycrystalline diamond based on Rittinger's law of comminution which equates to:

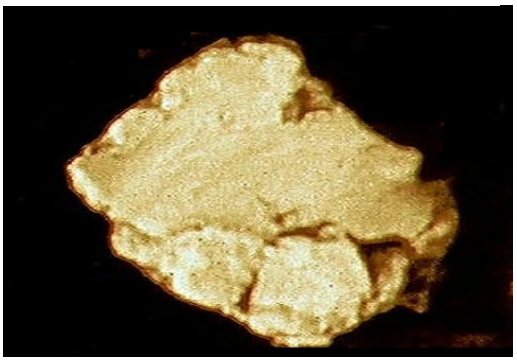
$$E = K(1/D2 - 1/D1)$$

E = energy input,
D1 = initial particle size,
D2 = final particle size,
K = constant

By Rittigner's law the final particle size is a complex function which is related to the initial partide size of the diamond feed and the amount of energy put into grinding. Therefore, if particle size were the only requirement, the yields for a given partide size or distribution can be manufactured by varying the grinding time or the energy of grinding.



High friability polycrystalline diamond produced at low crushing energy



Low friability polycrystalline diamond produced at high crushing energy

However, because polycrystalline diamond is a sintered material consisting of a distribution of crystallite shapes and sizes, the energy of grinding can significantly effect the final shape and friability of the polycrystalline diamond (see figures above). Therefore, as the tolerances for PTR, alumina recession, and surface become tighter for the lapping of magnetic hard tape and hard drive heads, control of both the particle size distribution, as well as the friability of the polycrystalline diamond will be required.