




DARMANN
ABRASIVE PRODUCTS
The Superfinishing Experts™

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ISOQAR
Certificate of Registration

The Art of Superfinishing.

DARMANN
ABRASIVE PRODUCTS

About Us.

Darmann Abrasive Products, Inc. has been designing and manufacturing fine grit, bonded abrasive products for superfinishing and precision grinding applications since 1983. Innovation, combined with superior engineering and unsurpassed customer service has made us a world-wide leader in the field. We have developed a unique value proposition which we call The Darmann Advantage.

Peter Johnson
President

The Darmann Advantage.

- **Darmann Is The Market Leader** – No one sells more superfinishing tools than Darmann. We provide the broadest range of conventional abrasive types, hardness, engineered structures, bond options, part geometries, packaging and printing. We've designed, manufactured and sold more than 10,000 different parts.

- **Consistent Fine Grit, Bonded Abrasive Products** – We've developed proprietary technology that addresses the exacting requirements of fine grit, vitrified bonded products. A number of factors go into the production of a consistent fine grit abrasive product. These include the use of raw materials that are sized within narrow acceptance ranges, good process controls and, most importantly, the ability to measure process parameters with sufficient granularity.

- **Superior Customer Service And Technical Support** – We believe our customers require more than just consistent, high quality products. This includes short lead times, free test samples, inventory management programs, and specialized packaging and shipping.

- **Innovative Research And Development** – We have ongoing research and development programs geared to the evolving needs of our customers. A major area of focus is the development of new and improved superabrasive technology, including the creation of new bond systems. Representative projects include new products to grind such challenging materials as ceramics, finishing of miniature bearings, and improved wheel technology.

We are committed to building on the traditions that have made us an important provider of superfinishing and superabrasive products. The company continues to make significant investments in new equipment, facility improvements, new technology and people. Most recently we have established sales offices in Poland and China, as well as a manufacturing facility in China expected to begin operations in 2007.

The Superfinishing Process.

Superfinishing, sometimes called micromachining or short-stroke honing, was invented in 1934 by Chrysler Corporation. However, it took about 40 years before gaining widespread acceptance.

During grinding, extreme heat and aggressive stock removal often alters micro structure and base metal hardness. This creates slight dimensional and surface imperfections such as smeared peaks, waviness and chatter.

Superfinishing, a low temperature, low stock removal process, improves part geometry and surface finish by removing the amorphous layer formed during the grinding process. This dramatically improves these imperfections, which can compromise part quality and performance.

Superfinishing Benefits.

The superfinishing process has a number of significant benefits, including the following:

- Increased part life.
- Decreased wear rates.
- Geometric improvements that allow for higher load bearing surfaces and quieter performing parts.
- Improved sealing capabilities.
- Elimination of the "break in period".
- Reduction in energy consumption.

How The Superfinishing Process Works.

The superfinishing process results in a controlled surface finish in which relatively small amounts of material are removed to achieve surface finishes as fine as 0.012um. While polishing processes attempt to achieve a mirror-like surface, superfinishing leaves a tightly controlled cross-hatch pattern. This pattern is attained by the interaction of three interrelated motions. These are **1**) Oscillation of the stone, or wheel rotation; **2**) Rotary movement of the component; **3**) Pressure of the abrasive tool on the workpiece. Stones are used to finish cylindrical shapes. Fine grit cups and cylinder wheels are used to finish flat and spherical surfaces.

During the superfinishing process, parts pass through several distinct phases. When the abrasive tool makes initial contact with the part, dull grains fracture or pull away from the matrix to produce a new cutting surface. As the tool "self dresses," relatively large amounts of stock will be removed from the workpiece. Proceeding through the stock removal phase, abrasive grains begin to dull, while surface irregularities and geometry continue to improve. This results in a cross-hatched surface free of irregularities and amorphous material.

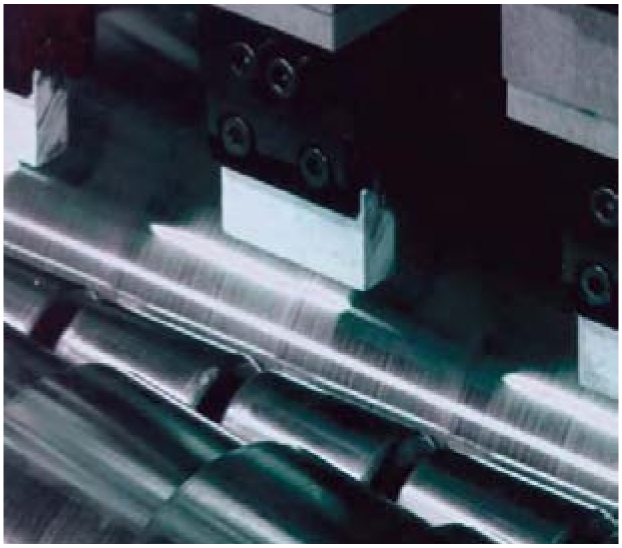
Methods Used In Superfinishing.

There are three primary methods used to superfinish components.

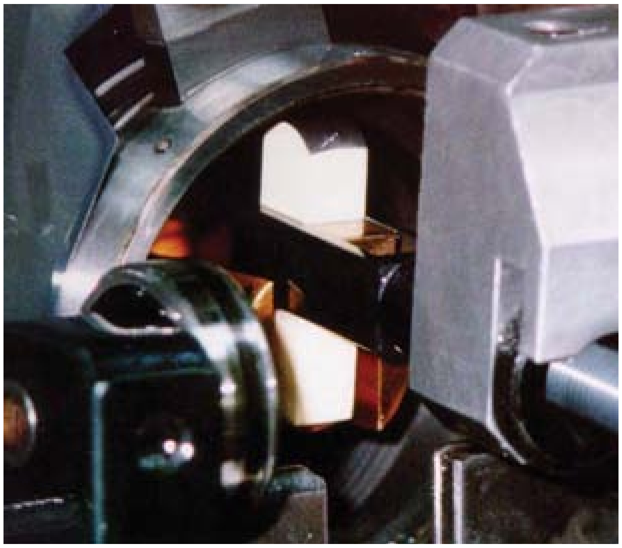
- **Through Feed Process** – This process is used to finish cylindrical parts, such as tapered rolls, piston pins, shock absorber rods, shafts, or needles. The parts are transported and rotated between two rotating drive rolls. The rotating workpiece passes underneath a series of four to eight stone stations with stones of decreasing grit size that are mounted to an oscillator mechanism. The oscillating stones contact the workpiece at a 90 degree angle, with appropriate pressure to achieve optimum results.

- **Plunge Process** – This process is commonly used to finish surfaces of irregular shaped parts. The workpiece is held and rotated, while a superfinishing stone makes contact. Two approaches can be used: **1**) The "single stone" approach uses one stone to finish the part. **2**) The "multi stone" approach uses different stones to perform "rough" and "finish" operations.

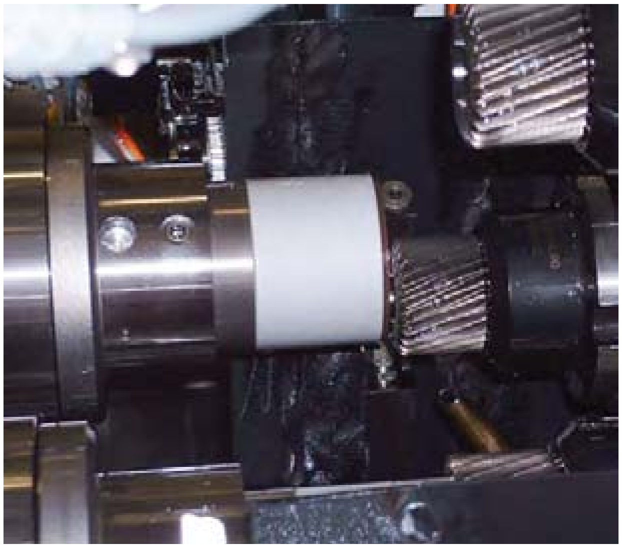
- **Superfinishing With Wheels Process** – Flat and spherical superfinishing can also be performed by using a cup wheel. With this process the workpiece and abrasive cup wheel are attached to rotating spindles. The "crosshatched" pattern results when the workpiece and cup wheel rotate in opposite directions. No oscillation occurs during this process. If the workpiece and cup wheel are parallel, the result will be a flat surface. Alternatively, if the cup wheel contacts the workpiece at an angle, a convex or concave surface will result.



Through Feed Process



Plunge Process



Superfinishing with Cup Wheels

Conventional Abrasives

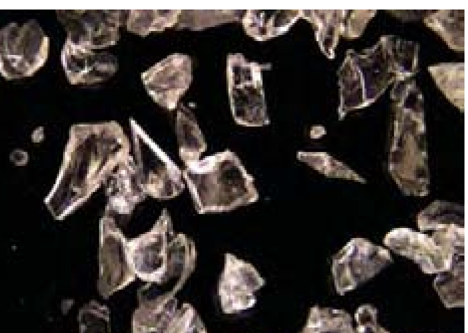
Example: WA 1000 – 70 G V2 S

ABRASIVE TYPE	GRIT SIZE	HARDNESS	STRUCTURE	BOND	TREATMENT
Aluminum Oxide	240	20 - Hard	**A** - Dense	**V** - Vitrified	**W** - Wax
WA	280				
FA	320			**R** - Resin	**S** - Sulfer
Silicon Carbide	400				
GC	500				
C	600				
Ceramic	800				
SA	1000				
Blends	1200				
FG	1500	280 - Soft	**N** - Open		

The performance of superfinishing stones and wheels, is determined by the abrasive type, grit size, hardness, structure, bond and treatment used.

Abrasive Types

- **Aluminum oxide** is made by refining bauxite ores. The degree of refinement is reflected in the color and toughness of the grain. Darmann uses two types of high purity aluminum oxide grains. Sintered white aluminum oxide (WA) is the purest and most friable form of aluminum oxide. Fused white aluminum oxide (FA) is also a highly pure grain, with a more angular shape. It is typically used for "roughing" operations.

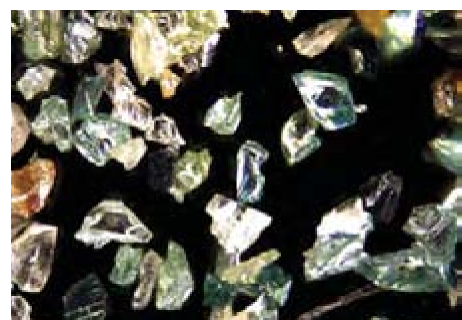


Fused White Aluminum Oxide

- **Silicone carbide** is made by combining pure white quartz, petroleum coke, sawdust and salt in an electric furnace. Hardness and purity are determined by the color of the crystals. Green silicon carbide (GC) is the purest form, while black silicon carbide (C) is less pure. Silicone carbide is a harder material than aluminum oxide, and has excellent finishing characteristics.

Sintered White Aluminum Oxide

- Although **CBN and diamond** materials have not gained widespread acceptance due to cost and performance limitations, recently they have gained wider acceptance in specialized applications. Darmann has developed both diamond and CBN products for use in superfinishing ceramic, M50 and other exotic materials used in orthopedic implants, bearings, and automotive parts. In addition, the company has also developed superabrasive solutions for the production of tapered rollers made of hardened steel.



Green Silicon Carbide

- **Graphite** is not an abrasive material, but is sometimes used to enhance the visual appearance of the workpiece. Blends of graphite, and an abrasive material such as aluminum oxide, combine the benefits of lubricity from graphite, with the cutting action of abrasive material.

- **Grit Size** – Superfinishing uses fine grit sized materials to achieve the desired finish. The sizing of abrasive grains is determined by organizations such as the Federation of European Abrasive Products (FEPA), and the Japanese Industrial Standards Committee (JIS). Most superfinishing processes use conventional abrasives with grit sizes between 400 and 1200 grit on the FEPA scale. Some applications, such as miniature bearings, may require the use of sub-micron sized particles. Generally, the use of finer grit sizes will improve surface finishes. The table shown in this paragraph compares the nominal grain sizes of conventional abrasive particles using the FEPA and JIS standards.

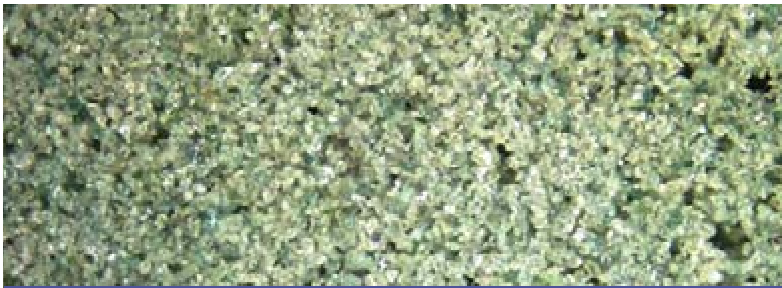
FEPA	JIS	Micron
320	500	35
400	700	23
500	1000	18
600	1200	14
800	2000	8
1000	3000	5
1200	4000	3
1500	6000	1

- **Hardness** – Hardness (or grade) is determined by the degree of strength abrasive materials are held in place. The hardness of an abrasive stone is largely determined by the amount of bond used to manufacture the product. Since most applications have narrow acceptance ranges for stock removal, finish requirements and cycle times, the production of fine grit, bonded abrasive products must be tightly controlled. Utilizing a proprietary tight tolerance grading methodology, Darmann ensures that stone and wheel production is consistent. The following table provides some factors to be consider when selecting a product grade.

Hardness Considerations	
• Harder Grades	• Softer Grades
– Light Stock Removal	– Heavy Stock Removal
– Better Stone Life	– More Free Cutting
– Better Finish	– "Rougher" Finishes
– Small Contact Areas	– Larger Contact Areas
– Finish Positions	– "Rougher" Positions
– More Stone Pressure	– Less Stone Pressure
– Used on Softer Materials	– Used on Harder Materials

- **Structure** – Structure is determined by the volume and arrangement of abrasive grains within a stone or wheel. Abrasive tool performance is determined by the interaction of the abrasive grain, bond and structure. The spacing of abrasive grains and pores should be evenly distributed to assure performance consistency "Open" structured products provide better clearance, and are less subject to loading than a closed abrasive tool.

GC600 "Open" Structure



GC600 "Closed" structure

- **Bonds** – Bonds are used to hold grains in place. Although resinoid bonds may be used, most superfinishing products are made with vitrified bonds which are used to manufacture tightly controlled products. Vitrified bonds are excellent for automated processes. These bonds are "self dressing," and eliminate the need to periodically interrupt production to conduct offline dressing operations. Darmann has developed a number of bonds specifically designed for fine grit, bonded abrasive products.

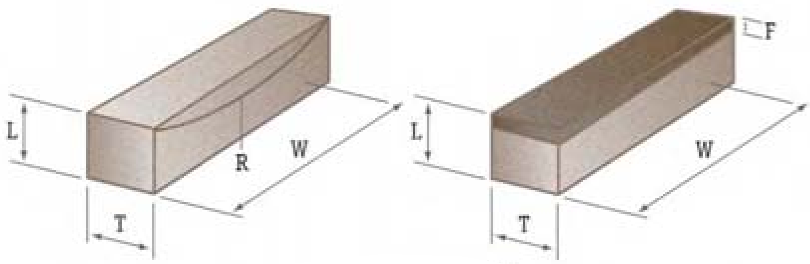
- **Treatment** – Either sulfur or wax treatment is commonly used to fill the porosity of stones. This provides lubricity to the contact area and reinforces the abrasive particles. Treated products tend to act harder, provide longer life, produce finer finishes and are less apt to "load". Sulfur tends to act harder than wax treated stones of the same hardness. Wax is preferred where the use of sulfur can result in stains, or ease of filtration is a major consideration.

Product Selection

Application	Method	Product	Station	Typical Specification	Material	Stock Removal	Surface Finish
Shock Rods							
Pre Chrome	Thru-feed	Stone Stone Stone	Rough Semi-finish Finish	WA500-100GV2S WA600-100GV2W WA800-100GV2W	Hardened Steel	3 to 5 microns	.1 Ra um
Post Chrome	Thru-feed	Stone Stone Stone	Rough Semi-finish Finish	WA400-170GV2S WA600-180GV2S WA800-200GV2S	Hard Chrome	2 to 3 microns	.03 Ra um
Wheel Hub Outer							
	Plunge	Stone	Rough/Finish	FA1000-100HV51S	Steel Forging	8 to 10 microns	.04 Ra um
Roller Lifter Center Pin							
	Thru-feed Stone	Stone	Rough/Finish	GC600-75FV2W GC800-150GV2W GC1000-150GV2W	Hardened Steel	2 to 3 microns	.04 Ra um
Piston Pins							
	Thru-feed	Stone Stone	Rough/Finish	GC600-100GV2W GC1000-180GV2W	Hardened Steel	2 to 3 microns	.03 Ra um
Diesel Camshaft							
Lobes	Plunge	Stone	Rough/Finish	GC800-35FV2S	1078 Steel, Induction Hardened	3 to 4 microns	.08 to .10 Ra um
Journals	Plunge	Stone	Rough/Finish	FA600-150FV51W		8 to 10 microns	.05 to .06 Ra um
Gear Pump Shaft Journals							
	Plunge	Stone	Rough/Finish	FA1000-180HV51S	Hardened Steel	4 to 5 microns	.3 Rz um
Ball Bearing Raceways							
Single Station	Plunge	Stone	Finish	FA1000-85HV51S	Hardened 52100 Steel	8 to 10 microns	.03 to .04 Ra um
Dual Station	Plunge	Stone	Rough/Finish	FA800-160GV51S GC1200-160GV2W	Hardened 52100 Steel	8 to 10 microns	.02 to .03 Ra um
Tapered Roller Bearings							
Rollers	Thru-feed	Stone	Rough Semi-Finish Finish	FA400-100IV2W FA500-95HV2W FA600-160IV2W	Hardened 52100 Steel	2 microns	.08 Ra um
Raceways	Plunge	Stone	Rough/Finish	FA600-75FV51W	Hardened 52100 Steel	8 to 10 microns	.06 to.08 Ra um
Cylindrical/Spherical Bearings							
Cylindrical Rollers	Thru-feed	Stone Stone Stone	Rough Semi-Finish Finish	FA500-80FV51S GC600-50FV2W GC1000-70FV2W	Hardened 52100 Steel	3 to 5 microns	.05 to .06 Ra um
Spherical Rollers	Plunge	Stone	Rough/Finish	FA1000-85V51S	Hardened 52100 Steel	8 to 10 microns	.03 to .05 Ra um
Raceways	Plunge	Stone	Rough/Finish	FA600-150FV51W FA800-160HV51W	Hardened 52100 Steel	8 to 10 microns 8 to 10 microns	.12 Ra um .10 Ra um
Hip Implants							
Femoral Heads	Plunge	Wheel	Rough Semi Finish Finish	GC320-35CV2S GC800-70GV2S GC1200-65FV2S	Cobalt Chrome	40 microns	High Polish
Femoral Heads	Plunge	Wheel	Rough Semi Finish Semi Finish Finish Polish	D25-20GV32100-289 D15-20GV31130-317 D9-20HV31120-316 D3-20JV3110-318 D1-20LV31-80-246	Ceramic	100 micron	High Polish
Fuel Injection							
Bore & Seat	Grind	Wheel	Rough/Finish	CB46-20HV1150-240	440 Stainless Steel	40 microns on Bore 100 micron on Seat	.06 Ra um

Stone and Wheel Dimensions

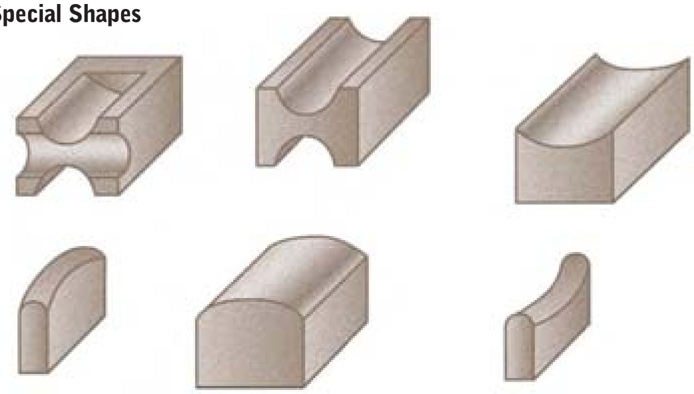
Stone Shapes



Conventional T X W X L; R

Superabrasive T X W X L; R (F)

Special Shapes



Tolerances

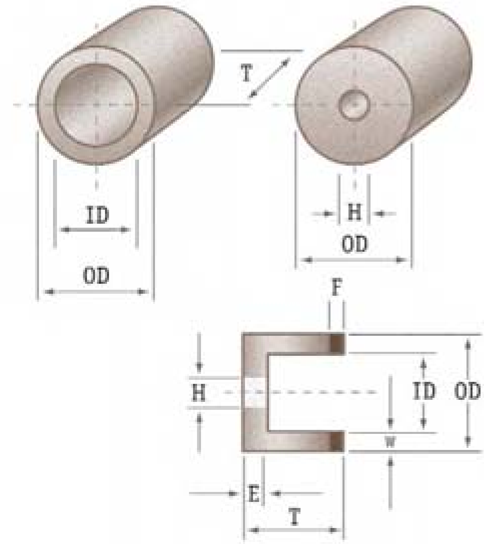
Thickness (T) ± 0.005" (0.13mm)

Width (W) +/1 0.005" (0.13mm)

Length (L) ± 0.050" (1.27mm)

Special tolerances available

Wheel Shapes



Conventional: OD/ID X T X H; E

Superabrasive: OD/ID X T X H; E (F)

Features & Types

Features: Slots, chamfers, holes, angles

Types: Cups - Mounted & one-piece

Rim wheels

Cylinders

Mounted wheels

Tolerances

Outside Diameter (OD) ± 0.005" (0.13mm)

Inside Diameter (ID) ± 0.005" (0.13mm)

Thickness (T) ± 0.005" (0.13mm)

Concentricity = 0.006" (0.15mm)

Flatness = 0.006" (0.15mm)

Special tolerances available

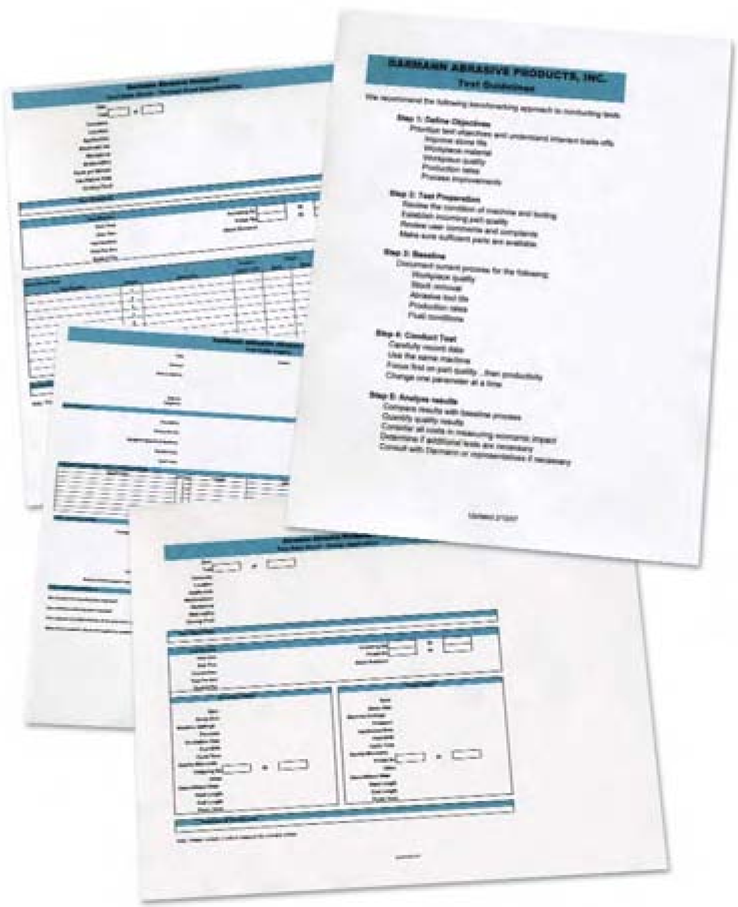
Packaging and Labeling

Maximize Performance through Benchmarking

To maximize process performance, it's necessary to conduct trial tests. There are a number of reasons for this, including the following:

- New machine installation.
- Introduction of a new part size.
- Changes to qualify parameters.
- Need to improve part finish/geometry.
- Reduced abrasive costs.
- Change in an upstream process such as grinding.
- Implementation of new coolant.
- Increased productivity.

Darmann recommends a benchmarking approach. Benchmarking is a documented study of the current process, together with related influences (e.g. incoming part quality). This practice enables the user to fully evaluate the outcome of subsequent trials.



There are five steps in the benchmarking process. These are:

1. **Define Objectives** – Develop a clear understanding of the test objectives, along with possible process trade-offs. For example, if the objective is to improve stone life, the use of a harder stone may impact the stone's cutting action.

2. **Test Preparation** – Make sure that sufficient parts are available to conduct a meaningful test. Review the condition of the machine, and associated tooling to be used. Establish incoming part quality representative of normal production conditions. Review concerns and complaints of those familiar with the process.

3. **Establish Baseline** – Document the current process. This includes incoming part quality, final part quality, stock removal, abrasive tool life, production rate, fluid conditions and other pertinent information. Use a data sheet that compliments internal record keeping, or use a standard one from Darmann.

4. **Conduct Test** – Tests need to be carefully recorded in order to make meaningful comparisons with the current process. Darmann recommends that the test be done on the same machine. Initial focus should be on achieving the desired part quality before attempting to realize productivity improvements or cost reductions. This usually means starting with softer grade stones, and using lower tool pressure. Further testing should be conducted by changing one machine parameter at a time.

5. **Analyze Results** – The value added of alternative abrasive tool options is determined by comparing the test results against the baseline process. Results should be quantified, and the cost impact calculated.

Common Problems and Corrective Actions

Problem	Operating Parameters	Abrasive Tool Selection
Finish		
Finish - rough	Increase spindle RPM Decrease oscillation Decrease pressure	Finer grit Harder grade Denser structure
Finish - fine	Decrease spindle RPM Increase oscillation Increase pressure	Coarser grit Softer grade More open structure
Material Removal		
Excessive stone wear	Increase spindle RPM Decrease oscillation Decrease pressure Increase coolant flow	Harder grade Denser structure
Low material removal	Increase pressure Increase oscillation Decrease spindle RPM Check incoming finish Check coolant	Softer grade Coarser grit More open structure
Part Quality		
Part out-of round	Decrease pressure Decrease spindle RPM Increase oscillation Check spindle to part alignment	Softer grade More open structure
Chatter marks	Check upstream grinding operation for high amplitude lobing or chatter	
Process Problems		
Excessive heat generated	Check coolant temperature Decrease pressure Increase coolant flow rate	Softer grade
Loading	Decrease spindle RPM Increase oscillation Check coolant	Softer grade Coarser grit More open structure
Stone Wear		
Uneven stone or wheel wear	Check spindle to part alignment	Harder grade
Excessive stone wear	Increase spindle RPM Decrease oscillation Decrease pressure Increase coolant flow	Harder grade Denser structure

Superfinishing Applications

Darmann has developed over 10,000 products for over 250 customers worldwide that represent a wide variety of applications. The following is a representative sample of products:

Automotive Chassis Products

- Shock Absorber Rods
- Strut Rods
- Steering Racks
- Power Steering Pump Components
- Transmission Components
- Wheel Hub Flange
- Flanged Wheel Bearing Units

Automotive Engine Products

- Lifter Roller Pins
- Fuel Injection Components
- Piston Pins
- Camshaft Lobes
- Crankshaft Journals

Diesel Engine

- Fuel Injection Components
- Camshaft Lobes and Journals
- Cam Follower Rollers

Hydraulic

- Cylinder Rods
- Pump Gear Journal
- Pump Gear Face
- Spherical End Pump Pistons

Bearings

- Ball Bearing Raceways
- Tapered Roller Cups and Cones
- Tapered Rollers
- Cylindrical Rollers and Races
- Spherical Rollers and Races
- Needle Rollers
- Miniature Bearings
- Ceramic Bearings
- Specialty Bearings

Medical

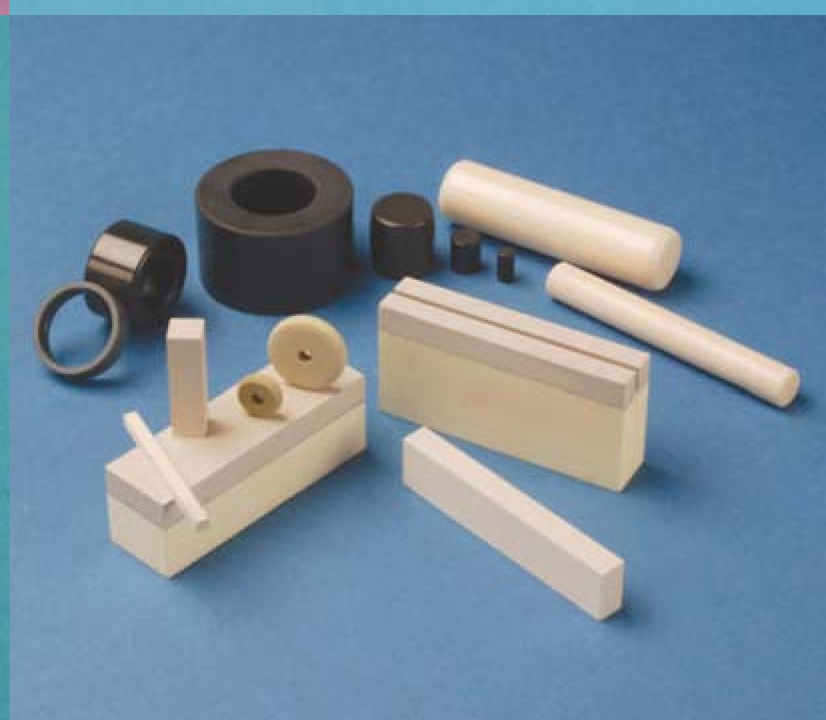
- Hip Implant: Femoral Heads
- Hip Implant: Femoral Sockets
- Elbow Implant Spheres

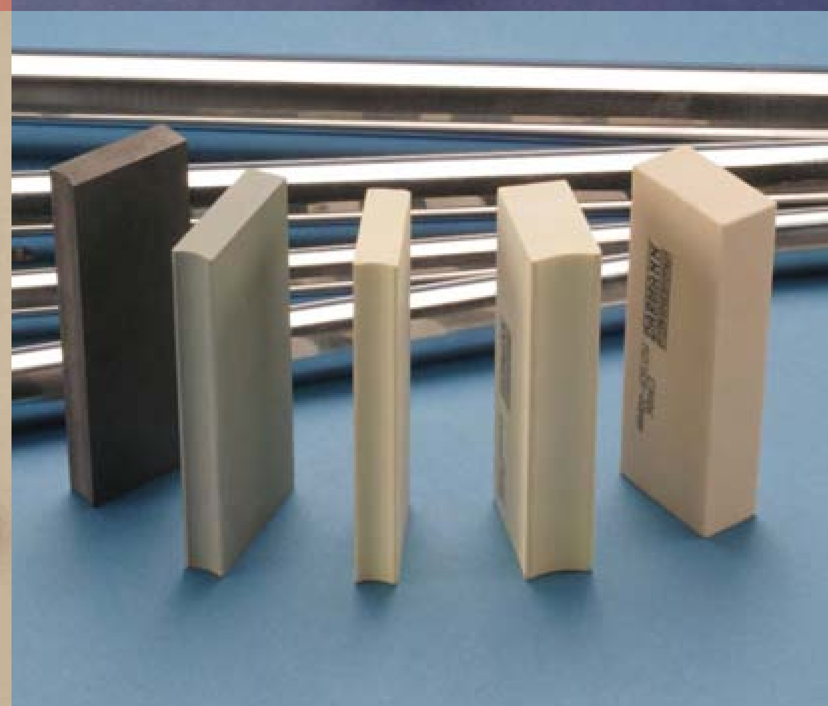
Additional Markets

- Semiconductor Dressing Boards
- Dressing Sticks
- Jointer Stones
- Finger Print Pads
- Sharpening Stones and Wheels
- Aerospace & Defense
- Industrial Products







We're Here To Work With You.

For over twenty years, Darmann has worked with companies of all sizes – from small manufacturing facilities, to Fortune 500 giants. During that time we've partnered with literally hundreds of companies to improve thousands of manufacturing processes.

With a newly expanded presence, Darmann is now able to assist companies in Asia, Europe and North America. We hope you join a growing list of world-wide firms who have come to depend on Darmann expertise and commitment to solve their abrasive problems.

We're here to work with you.