VESPEL®

SHAPES: SP POLYIMIDE MACHINING STOCK

FOR PERFORMANCE THAT PAYS

DUPONT®

High Performance Parts for Your Special Needs

Any mechanical device is only as good as its weakest component. For more than 20 years, engineers have been improving machines by replacing those "weak links" with VESPEL® polyimide parts—

■ Original equipment manufacturers' engineers who are concerned with reliable operation of automobiles, off-road vehicles, aircraft, business machines, high performance valves, electronic devices and other equipment rely on VESPEL parts.

■ Plant maintenance managers who are determined to reduce downtime on troublesome equipment specify VESPEL parts.

■ Other manufacturing engineers in virtually any industry use VESPEL parts to help improve performance and reliability as well as to reduce maintenance or warranty claims, in order to keep overall costs down.

VESPEL parts have a combination of properties that allows them to perform where other materials cannot. For example, they provide:

■ ***Outstanding wear resistance*** in either lubricated or unlubricated environments. These parts can withstand dry pressure velocity values to 300,000 psi-fpm, and considerably higher when lubricated.

■ ***Continuous operation from cryogenic temperatures to 550°F (288°C)*** with short-term use to 900°F (482°C) and above.

■ ***Load-carrying capabilities*** at temperatures beyond the reach of other plastics while retaining excellent resistance to creep.

■ ***Low thermal and electrical conductivity.***

■ ***Sealing compliance*** with outstanding resistance to permanent deformation. The yielding surface of a VESPEL part provides a better seal than many metal-to-metal seals machined to much higher tolerances, and can eliminate costly hand lapping.

■ ***Excellent machinability*** without special equipment or procedures.

To ensure quality and supply, only DuPont manufactures standard VESPEL shapes for machining stock and custom-made VESPEL parts at production facilities in the United States, Japan and Europe.

VESPEL® Shapes Machine as Easily as Brass

While DuPont can supply finished machined parts, you can easily do your own machining using VESPEL shapes.

With standard metal-working equipment, you can machine VESPEL shapes to tolerances once considered too close for plastic materials. In most cases, the techniques used for machining metals such as brass are directly applicable. VESPEL shapes are relatively easy to machine because of their high mechanical strength, stiffness and dimensional stability at machining temperatures.

For a complete guide to machining parts from VESPEL shapes, ask for a copy of Machining DuPont VESPEL Parts.

Direct-Formed Parts for Cost Savings on Larger Quantities

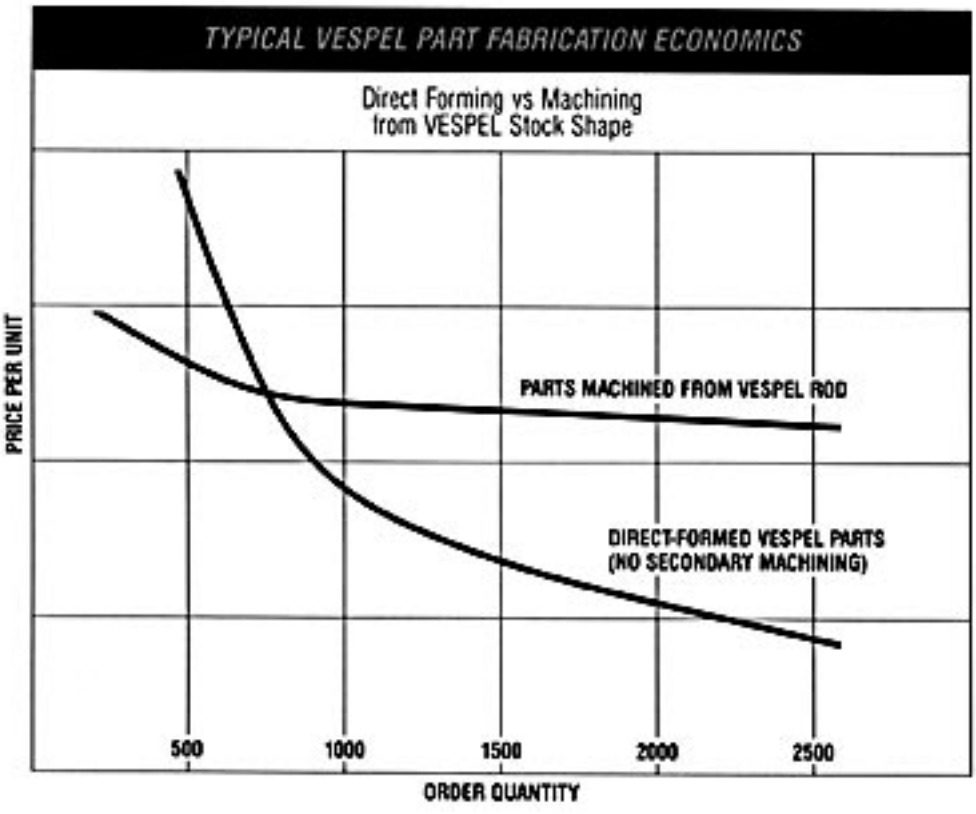
Machining parts from VESPEL shapes is usually the most practical route to producing small quantities, prototypes, or parts with highly complex geometry.

For production quantities of 500 or more, VESPEL parts can often be most economically fabricated by the DuPont direct-forming process.* Direct forming uses powder metallurgy techniques to produce finished or semi-finished parts, and minimizes material wastes. Machining can often be eliminated. Long production runs also produce labor savings which can be passed along as lower part prices.

The chart below gives an example of how part cost varies with quantity for an uncomplicated polyimide ring.

Due to the variety of factors that arise in determining the most economical fabrication process for an individual part, you should consult with a VESPEL sales engineer at the earliest stage of part design.

* In some cases, depending on part size or complexity, direct-forming may be economical at even lower quantities.



VESPEL® Parts and Shapes . . . Compositions to Match Your Needs

VESPEL shapes are available in five compositions of SP polyimide resin. You can select the composition which provides the optimum properties for your specific application:

■ ***Physical and Electrical Properties:***
SP-1 the unfilled base resin, provides maximum physical strength, elongation and toughness and best electrical and thermal insulation properties. Typical applications include spacers, soldering fixtures, valve seats, balls, gaskets, poppets and static seals.

■ ***Wear and Physical Properties:***
SP-21 has 15% graphite, by weight, added to the base resin for low wear and friction in applications such as bearings, thrust washers, bushings, seal rings, slide blocks and other wear surfaces. SP-21 has the maximum physical strength, elongation and toughness of our graphite filled resins.

■ ***Wear and Dimensional Stability:***
SP-22 has 40% graphite, by weight, added to the base resin which provides enhanced resistance to wear and friction as well as improved dimensional and oxidative stability. SP-22 has the lowest coefficient of thermal expansion. Typical applications are the same as for SP-21.

■ ***Low Coefficient of Friction and Unlubricated Wear:***
SP-211 has 10% TEFLON® resin and 15% graphite, by weight, added to the base resin to provide the lowest coefficient of friction over a wide range of operating conditions. It also has excellent wear resistance up to 300°F (149°C). Typical applications include sliding or linear bearings as well as many wear and friction applications listed above.

■ ***Unlubricated Sealing and Wear in Vacuum or Dry Environments:***
SP-3 has 15% molybdenum disulfide, by weight, added to the base resin. SP-3 provides maximum wear and friction resistance in vacuum and other moisture-free environments, where graphite actually becomes abrasive. Typical applications include seals, bushings, bearings, gears and other wear surfaces in outer space, ultra-high vacuum or dry gas applications.

■ ***TABLE I: SUMMARY OF TYPICAL PROPERTIES*** **(Machining Stock)**

Property	Method	(°F) Temp	Units	SP-1	SP-21	SP-22	SP-211	SP-3
Tensile Strength,	ASTM	73	PSI	12,500	9,500	7,500	6,500	8,200
Ultimate	D-638	500	PSI	6,000	5,500	3,400	3,500	—
Elongation,	ASTM	73	%	7.5	4.5	3.0	3.5	4.0
Ultimate	D-638	500	%	7.0	2.5	2.5	3.0	—
Flexural Modulus	ASTM	73	10^3 PSI	450	550	700	450	—
	D-790	500	10^3 PSI	250	370	400	200	—
Compressive Modulus	ASTM D-695	73	10^3 PSI	350	420	475	300	—
Wear Rate, PV = 25,000	Unlub.		in/1000	.25–1.2	.09	.06	.07	.25–.33
Friction Coefficient								
Dynamic*	Unlub.			.29	.24	.20	.12	.25
Static				.35	.30	.27	.20	—
Static in Vacuum				—	—	—	—	.03
Coefficient of Linear Expansion	E-228	73–572	10^{-6} in/ in/°F	30	27	21	30	—
Dielectric Constant	D-150	73	@10^4 Hz	3.64	13.28	—	—	—
Underwriters Laboratory Flame Rating: 94-VO								

** Steady state, unlubricated in air. PV = 25,000 psi fpm*

NOTE: These are typical properties for machined parts. Properties typical of other manufacturing processes may vary. For example the coefficient of linear expansion for direct-formed parts can be 7% to 24% less than the values shown above, depending on the resin composition.

Standard VESPEL® Shapes

These descriptions give an overview of the range of sizes in our standard VESPEL shapes line. However, we often can produce shapes to meet special needs. If you don't see what you need here, call us.

Details of prices and availability of standard VESPEL shapes are in the current price list.

Rods

Rods are available in several different diameters from $^{1}/_{4}$″ to $3^{1}/_{4}$″. Lengths of $9^{1}/_{2}$″ and 38″ are available.

Plaques

Plaques are sold in 5 thicknesses, from $^{1}/_{4}$″ to 2″. Face dimensions offered are 10″ × 10″, 10″ × 5″ and 5″ × 5″.

Tubes

Heavy-walled tubes are available in 33″ lengths with ODs ranging from 1.6″ to 7.1″. Some tubes are also offered in 8″ lengths.

Bars

Bars are 2″ × 4″ × 38″ in length.

Direct Formed Rings

A variety of rings and discs are offered in diameters ranging from $^{5}/_{8}$″ to $2^{1}/_{2}$″ with thickness of $^{1}/_{8}$″ and $^{1}/_{4}$″.

Standard Size Balls

Balls are available in diameters ranging from $^{1}/_{8}$″ to $^{5}/_{8}$″.

For complete details on available sizes, see the inside back page of the brochure.

VESPEL® Parts Handle the Tough Applications

■ *U.S. Navy Uses VESPEL Adapter in Improved Spline Coupling for Aircraft*

In airplane spline couplings, used to drive generators, hydraulic pumps, and other equipment, VESPEL adapters were designed to replace all metal couplings. The configuration and compressive strength of the VESPEL parts allows them to carry high torque loadings without lubrication. In U.S. Navy fixed wing aircraft generators, they increased wear life 50 times over that for conventional greased couplings. The VESPEL adapters are self-lubricating, making special lubrication or cleaning of the splines unnecessary.

■ *VESPEL Bearing Increases Wear Life in Textile Equipment*

A one-piece VESPEL bearing element, used in yarn-winding machinery, gives up to double the service life of steel ball bearings while reducing parts cost 30 to 50 percent. The VESPEL bearing is part of an assembly that stops bobbins rotating at up to 10,000 rpm—in about 15 seconds. Neither steel nor other engineering plastics performed adequately under the extreme mechanical and thermal stresses found in this application. The tough VESPEL parts improve machine performance and cut maintenance costs.

■ *VESPEL Valve Seals Pass Critical Test in Ultra-High Vacuum System*

VESPEL valve seals used in ultra-high vacuum systems perform reliably at temperatures as high as 300°C. The tough VESPEL seals are lighter, more compliant, and more economical than metal, the only other seal material able to withstand such high temperatures. VESPEL seals allow valves to be sealed vacuum-tight with ordinary hand knobs and require no external lubrication.

■ *VESPEL Piston Rings Solve Wear Problem in Gas Compressors*

Three-piece VESPEL piston rings last four times longer than laminated phenolic rings on ethylene compressors with discharge pressures to 440 atmospheres and temperatures of 200°F. The rings, lubricated by a blend of polybutene and mineral oil, run against steel liners with a 16 RMS surface finish. The compressors have a 14 inch stroke and operate at 300 rpm. The longer-lasting VESPEL parts reduced compressor downtime and maintenance.

Standard Shapes Dimensions

RODS

Minimum Diameter		Minimum Length		Minimum Length	
in	mm	in	mm	in	mm
1/4	6.3	9 1/2	241	38	965
3/8	9.5	9 1/2	241	38	965
7/16	11.1	9 1/2	241	38	965
1/2	12.7	9 1/2	241	38	965
5/8	15.8	9 1/2	241	38	965
3/4	19.0	9 1/2	241	38	965
1	25.4	9 1/2	241	38	965
1 1/4	31.7	9 1/2	241	38	965
1 1/2	38.1	9 1/2	241	38	965
2	50.8	9 1/2	241	38	965
2 1/2	63.5	9 1/2	241	38	965
3 1/4	82.5	9	228	27	685

PLAQUES

Minimum Thickness	
in	mm
2	50.8
1 1/2	38.1
1	25.4
1/2	12.7
1/4	6.4

TUBES

Diameter Minimum OD		Maximum ID		Minimum Length	
in	mm	in	mm	in	mm
7.1	180	5.6	142	33	838
6.7	170	5.6	142	33	838
6.4	162	5.6	142	33	838
6.7	170	4.7	119	33	838
5.9	149	4.7	119	33	838
5.6	142	4.7	119	33	838
6.5	165	4.3	109	33	838
6.1	154	4.3	109	33	838
5.7	144	4.3	109	33	838
5.4	137	4.3	109	33	838
4.8	121	4.3	109	33	838
5.4	137	3.4	86.3	33	838
4.9	124	3.4	86.3	33	838
4.3	109	3.4	86.3	33	838
3.7	94.0	3.4	86.3	33	838
5.1	129	2.6	66.0	33	838
4.7	119	2.6	66.0	33	838
4.0	101	2.6	66.0	33	838
3.4	86.3	2.6	66.0	33	838
4.9	124	1.9	48.2	33	838
4.4	111	1.9	48.2	33	838
3.7	94.0	1.9	48.2	33	838
3.1	78.7	1.9	48.2	33	838
1.7	43.1	1.4	35.5	27	685
1.6	40.6	1.1	25.4	27	685

BARS

Minimum Cross-Sectional Dimensions Width × Thickness	
in	mm
4 × 2	101 × 50.8

RINGS & DISCS

A variety of rings & discs are offered in diameters ranging from 5/8″ (15.8mm) to 2 1/2″ (63.5mm) with thickness of 1/8″ (3.1mm) 1/4″ (6.3mm).

BALLS

Diameter	
in	mm
.125	3.2
.250	6.3
.375	9.5
.500	12.7
.625	15.8

Most outside dimensions listed above are minimum dimensions. Actual inside diameter of tubes are slightly smaller than shown. Ball diameter tolerances are ±.002″.

The extraordinary properties of VESPEL parts may not always be required. Where performance requirements are low, commonplace materials may be used successfully. But in tough applications, the purchase price of VESPEL parts is quickly offset by savings in manufacturing, reliability and longer component life.

If you think our superior performance and reliability can help you trim overall costs, call your local VESPEL sales engineer or a sales office listed on the back of this brochure.

More information on the benefits and properties of VESPEL parts is available in these brochures:

"VESPEL Custom High Performance Parts" (E-61486)

"Properties of VESPEL Parts" (H-15724-1)

"Guide to Machining VESPEL Parts" (E-61497-1)

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All of the property data discussed in this brochure are based upon laboratory tests and/or performance of VESPEL parts in specific applications. The maximum use temperature, PV limit and other performance parameters of virtually all engineering materials will vary somewhat from application to application, and between laboratory data and actual applications, depending upon a number of factors intrinsic to each application. Therefore, the only way to determine how VESPEL parts will perform in your application is to test them in your application.

DuPont warrants only that the material itself does not infringe the claims of any United States patent; but no license is implied nor is any further patent warranty made.

CAUTION: Do not use DuPont materials in medical applications involving permanent implantation in the human body or permanent contact with internal body fluids or tissues.

Do not use DuPont materials in medical applications involving *brief or temporary implantation* in the human body or contact with internally body fluids or tissues, unless the material has been provided directly from DuPont under a contract which expressly acknowledges the contemplated use.

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(10/93) 233633A Printed in U.S.A.
[Replaces: E-61482]
Reorder No.: E-61482-1