

## Technical Article

### PPS: THE UNSUNG HERO OF HIGH-PERFORMANCE THERMOPLASTICS

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Polyphenylene sulfide, PPS, is truly the unsung hero of high-performance thermoplastics. PPS has been specified in thousands of highly engineered applications in every market from aerospace and automotive to medical, electronics, and construction for over 20 years. Whenever extreme conditions and environments called for higher heat capacities with low smoke generation, exceptional chemical resistance, or exacting dimensional stability and strength, PPS has been quietly called upon to meet the most demanding requirements.

In the new millennium, PPS is offered in more formulations, through more manufacturing processes, and in more end products than ever before. The complete list of available formulations is growing so rapidly that it is difficult to track it all. Neat grades that exhibit high purity levels are complemented by glass-filled variations and impact modifiers for enhanced mechanical properties. Advances in process technology have kept pace and even expanded the market potential of PPS greatly just within the last few months.

#### Injection molding

PPS has been heavily specified in injection molded products for over two decades. The versatility of PPS allows it to be molded into components for demanding applications that require exacting tolerances. PPS is very often utilized in overmolding and insert molding processes for finished and semi-finished products.

Applications include aerospace and automotive products where strength-to-weight ratios combine favorably with the material's inherent flame resistance and chemical resistance. Electronics manufacturers select PPS for insulation and connector applications when high continuous operating temperatures are a consideration. Medical products that require low moisture vapor transmission and repeated autoclave cycles are prime candidates for PPS materials.

#### Extruded stock shapes

Fabricators have enjoyed the availability of PPS for manufacturing high-performance products since the early 1990s. PPS machines well in conventional processes and is known for its ability to hold demanding tolerances with minimal creep. It can be bonded, welded, and painted with minimal, if any, preparation.

PPS is available in thick-walled tubing having diameters to 14 in. that can be machined into shorter sections or rings. Extruded rods come in standard and custom lengths with diameters that range from 0.250 to 2.5 in.. Plates range in thickness from 0.250 to 2.75 in. and are available in stock and custom lengths and widths.

End markets for extruded stock shapes closely mirror those of other processes as defined by the economics of fabricated production. Applications in the semiconductor industry for wafer and disk production and/or polishing had been prominent before the downturn in that industry.

#### Compression molding

Compression-molded PPS is available in stock shapes, as well as in detailed finished and semi-finished custom molded products. Compression molding can produce very heavy-section molded products within exacting tolerances. As with most thermoplastics, heavy wall sections are not available through injection molding.

Stock shapes of compression-molded PPS include heavy plate sections up to 3.5-in. thick in custom widths and lengths. Short section rods are molded up to 4 in. in diameter and tubing is available up to 58-in. diameter and up to 6-in. thick. Disks for fabrication are available with diameters to 26 in. and thicknesses from 0.5 to 3.5 in.

#### Profile extrusions

As you would expect, high-performance PPS profiles are also available via extrusion. Once again, a wide range of formulations are available for the most demanding applications. Tooling and die considerations for PPS engineered profiles are consistent with most high-performance materials.

PPS profiles are utilized in gas pipe and well liners to protect the steel piping from aggressive chemicals. PPS profiles and edge trims are also available to complement other PPS products in chemical tank lining applications.

#### Sheet and roll/coil extrusion

Recent advances in resins and process technology have made PPS available in thin gauge sheet and coil/roll products for the first time. This is far from a limited offering in a new format. A complete selection of grades and formulas, with and without reinforcements and additives, has been developed with thicknesses that range from 0.010 to 0.250 in. and standard widths up to 48 in. Metric and plus sizes are available on special order.

The markets for these products include chemical tank liners with fabric backing, polishing disks for hard drives and optical devices, and thin fabricated products. Slit coils are available for the fabrication market as narrow as 0.250 in. Punched parts manufactured with PPS include washers, spacers, seals, and gaskets for automotive and other demanding applications.

The entry of PPS into the thin-gauge, high-performance market is significant. The recent advances in resins and process technology that make this material available for the first time also provided process economics that allow thin-gauge PPS to be competitively priced with other thin-gauge HPM's that have significantly lower thermal and mechanical capabilities. Fabricators can also benefit by purchasing material that is much closer in size to their finished products.

#### Thermoforming

Complementing a full selection of grades and formulas for fabricators is an equally impressive line-up of thin-gauge thermoformable PPS materials. These new PPS grades include neat, glass-filled and impact-modified formulations similar to those employed for the fabrication market. The most significant difference is the extended range of melt temperatures that make forming possible.

Thermoformable grades of PPS are available in sheet and roll/coil configurations from 0.010 to 0.250-in thick in standard and custom widths up to 48 in. Again, metric and plus sizes are available upon request. A developmental thermoformer for PPS reports forming temperatures well within the range of commercial equipment at 550° to 600°F depending on tool design, material thickness, and part configuration. Drying of the PPS sheet prior to forming is not required.

Thermoformed PPS presents great opportunity for large thin-walled panels, as well as intricate, highly detailed, configurations. The markets for thermoformed PPS are as wide and varied as with all of the other processes because thermoforming can bridge the gaps between fabricated, compression molded, and injection molded applications.

Summary:

PPS might have once been a boutique resin applied sparingly in demanding applications. Today, it is a high-performance powerhouse that provides exceptional properties and features with very competitive benefit/cost ratios across a broad spectrum of market sectors. PPS is now available in more grades and formulations, as well as more processes, than ever before. Looking ahead, it holds great promise for, as is true with all resins, new materials = new opportunities = new customers.