

## Technical Article

The recent introduction of a line of High Performance Forming Materials by Ensinger/PennFibre has created opportunities for thermoformers to compete in growing global markets previously unavailable to them. For the first time, engineered formulations of Acetals, Nylons, and Polyphenylene Sulfide, are available in both sheet and roll stock in thermoforming grades. Additionally, an exciting selection of boutique resins complimenting these materials includes super gloss molding alloys, fluoropolymers, and thermoplastic elastomers.

The development of these new materials by Ensinger/PennFibre was, and continues to be, a collaborative effort at several levels. Global resin manufacturers have invested heavily in perfecting formulations with enhanced properties that facilitate the forming process. Thermoforming equipment manufacturers have validated new materials for formability in their labs. Real world processing conditions have been successfully applied by thermoforming development partners.

As with Ensinger/PennFibre's line of engineered fabrication materials, most of these new materials are available in both sheets and rolls in thicknesses from .010" to .250", and in stock and custom widths up to 48". Optional features on most materials include a variety of fabric backings; woven, non-woven, and knitted, for gluing applications as well as ESD additives for specific levels of resistivity and varying levels of glass reinforcement.

Ensinger/PennFibre's line of High Performance Forming Materials are available direct from Penn Fibre in North America. International markets are served through the Global Ensinger Network of plastics companies.

### Pennite® Nylons:

In February of 2003 Ensinger/PennFibre introduced Pennite® 4508 thermoformable, type 6 nylon, with 15% glass fiber. Pennite®4508 is heat-ageing stabilized material with a continuous service temperature of 140°C/284°F and a peak operating temperature of 170°C/338°F. The primary target market for this material is expected to be in under the hood applications.

The initial validation of Pennite® 4508 was performed by Adolf Illig Maschinenbau GmbH and Co., of Heilbronn, Germany in September of 2002. Illig is the premier manufacturer of both roll fed and sheet fed forming equipment in Europe. Illig has provided recommendations for drying and processing to aid project startups. Our developmental forming partners, Freetech Plastics, Inc. of Fremont, Ca. and Magee Plastics, Inc. of Warrendale, Pa. have both performed extensive forming trials of Pennite®4508 successfully.

Following the successful introduction of Pennite® 4508 was Pennite® 4509, a neat version of type 6 nylon, and Pennite®4510, a type6/6 material with 15% glass loading. The early reception of these materials in the market has, and continues to be, brisk.

Pennite®4508 is being twin sheet formed into an aftermarket air dam for Series 3 BMW automobiles. Freetech Plastics manufactures the air dam for their customer, Dinan Corporation, the high performance BMW engineering firm of Morgan Hills, California. Pennite®4508 was selected for this application because of its high heat capacity, ease of processing, and ability to meet all of the OEM specifications for BMW materials. Freetech is currently preparing to release several more new items for this line of high performance under the hood products.

#### DuPont™ Forming Solutions:

The DuPont™ Forming Solutions family of materials is the result of the extensive development efforts of DuPont™ Engineering Polymers. As the nations largest thin gauge extruder of Delrin® Acetals and Zytel® Nylons, the introduction of these new materials by Ensinger/PennFibre has been a natural extension of existing product lines.

#### DuPont™ Delrin® Forming Solutions:

Delrin® FS is the worlds first and only thermoformable acetal. After over forty years as a leading material in the stock shapes market, and billions of pounds in the injection molding industry, DuPont™ Delrin® homopolymer acetal is now available to the thermoforming community.

The same great features that have made Delrin® acetals so successful and popular in its original processes are now found in thermoformed products. Delrin® FS offers a high strength to weight ratio, exceptional dimensional stability, low moisture vapor transmission rate, high resistance to chemicals, fuels, and solvents, and superior wear, scratch, and scuff resistance. Delrin® FS is available in a wide range of colors, with options that include varying levels of glass reinforcement, and ESD additives.

The original market targets for Delrin® FS mirror existing acetal markets with the addition of the economics offered by the thermoforming process. Automotive applications include interior body panels, instrumentation products, and fuel system components. Medical equipment and devices, consumer electronics, major household appliances, sporting goods, and bearing and wear applications are all anticipated markets for Delrin® FS.

The formal validation of Delrin® FS was performed by Illig. Illig again provided a detailed set of parameters for processing. Our development partners at Freetech Plastics and Magee Plastics have also performed numerous trials of the material in a variety of thicknesses and processing methods. Freetech Plastics has the distinction of being the first thermoformer to form Delrin® FS, prior to formal validation, and also the first to manufacture a commercial product with Delrin® FS.

#### DuPont™ Zytel® Forming Solutions:

Zytel® FS, thermoformable nylons, are premium nylons developed for thermoforming applications that require even high heat capacity and enhanced mechanical properties. Zytel® FS is available in a wide range of type 6 and type 6/6 formulations with glass loadings and ESD additives upon request.

The enhanced mechanical properties of Zytel® FS are complimented by an elevated HDT of 180°C/356°F which make Zytel® FS a preferred choice for the most demanding under the hood applications. Covers, shrouds, and twin sheeted ducts and dams are just a few of the areas where this material will make new opportunities for the economics of thermoforming. Industrial applications for Zytel® FS will parallel the millions of products that have been manufactured with nylons for decades.

#### DuPont™ Hytrel®:

The Hytrel® families of materials are thermoplastic elastomers that have been well established in numerous marketplaces. Thermoformable grades of Hytrel® range in durometer of 40 to 80 Shore D. Thermoformable Hytrel® operates in a very broad temperature range and provides exceptional chemical resistance to hydrocarbons and fuels found in automotive applications. Hytrel® provides the flexibility of rubber with the strength and toughness of an engineered thermoplastic giving finished products a “soft touch feel” that has a very high resistance to wear and tear.

Primary markets for formable Hytrel® compliment existing uses for TPE's in seals and gaskets for automotive applications as well as a long list of industrial and commercial products and mechanical devices requiring high flex and fatigue capabilities. Formable Hytrel® is available in natural as well as a wide range of custom and stock colors. Custom formulations compliment a wide range of standard offerings to meet the most demanding of applications.

#### DuPont™ Surlyn® Reflection Series:

The Surlyn® RS is a family of modified ionomer resins developed for high gloss applications that require extended weatherability combined with superior scratch and wear resistance. Targeted at automotive body panels, consumer electronics, and major appliance markets, Surlyn® RS materials are available in a wide range of vibrant stock colors and may be custom compounded to provide exacting color matches.

Surlyn® RS materials provide excellent chemical resistance to gasoline and most common under hood fluids. Surlyn® RS materials provide a superior surface finish without the need, or investment required, for painting. Surlyn® RS also offers economics in recycling in that paint contamination is no longer a consideration.

#### Fortron® PPS (polyphenylene sulfide):

Fortron is a linear, semi-crystalline polyphenylene sulfide with exceptional high performance characteristics. Fortron® PPS is rated UL 94 V0, is inherently flameproof, and has a continuous service temperatures in excess of 240°C/464°F. Fortron® PPS offers extreme chemical resistance to known solvents, very low water vapor transmission, high hardness and strength, and low creep, even at elevated temperatures.

Ensinger has long been a global leader in the production of Fortron® PPS in large diameter tubes, heavy section plates and rods, extruded profiles, and both injection and compression molded products. The introduction of Fortron® PPS in thin section products, as low as .010” thin, by Ensinger/PennFibre, is again a natural extension of the product line. The developments of several new formulations specifically for thermoforming open the industry to new and very sophisticated applications.

The primary markets for Fortron® PPS align with other processes in automotive, aerospace, public transportation, electronics and semi-conductors, construction, and medical markets. The economics of thermoforming make large thin wall section and smaller intricate products viable for all of these markets.

#### Solef® PVDF:

Solvay fluoropolymers, particularly PVDF, have long been favored in the chemical industry for the containment of aggressive chemicals in transport. Solef is offered by Penn Fibre, with and without fabric backings, for thermoformed tank liners as well as fabricated installation in gas lines and large tank lining applications.

Solef PVDF provides a unique combination of chemical resistance properties coupled with a broad continuous operating temperature and intrinsic fire resistance. Automotive applications include heat resistant under hood components, fuel tanks, and hoses.

**Udel® Polysulfone:**

Udel is a high strength thermoplastic that maintains its mechanical properties at elevated temperatures. Udel is often utilized to replace polycarbonate when higher temperatures or improved chemical resistance is required.

Automotive applications for Udel are numerous and include; under the hood and electrical components, sensors and electrical ignition systems, battery caps and fuses. Udel has broad usage in other markets including electrical and electronics products, medical applications requiring repeated sterilization, and consumer products.

**Ultem® Polyetherimide:**

Ultem has been known for years as a high performance resin with good chemical resistance, high heat characteristics, inherent flame retardancy, and demanding dimensional stability. Ultem has been a favored material in a wide range of public transportation mediums.

Automotive applications abound and are complimented by long service in aerospace and rail interior cabin components. Some of the key features of Ultem in these markets have been the low smoke contribution rate that meets the standards of all of the governing agencies and the resistance to a broad range of chemicals including automotive fluids.

Ultem XHT, a new offering this year, was developed for even higher heat applications. Ultem XHT has, in addition to the other properties of Ultem, a higher HDT of 450°F which considerably raises the market potential for this material.

**Summary:**

Anytime that a plastics processor, in this case thermoformers, offer higher heat capacities, higher chemical resistance, and higher mechanical properties, coupled with ease of processing and consistent supply, new markets and opportunities become available to them. The economics of thermoforming versus other processes can now be applied with competitive materials, which meet OEM specifications, and are well known and respected for their long service in numerous applications that span every market. The importance of these new materials is manifest in a simple equation; new materials = new markets = new opportunities.

Penn Fibre Plastics has been providing market opportunities since 1937 with the introduction of new materials and technologies. The tradition continues.

DuPont, Delrin, Zytel, Hytel, and Surlyn are tradenames and registered tradenames of E.I. DuPont & Co. and are used under license to Penn Fibre Plastics, Inc. Pennite is a registered tradename of Penn Fibre Plastics, Inc. Fortron is a tradename of Ticona, a business unit of Celanese AG. Udel and Solef are tradenames of Solvay. Ultem is a tradename of GE.

**Contact:**

David A. Pincin, National Sales Manager  
800-662-7366  
penninfo@pennfibre.com