UNDERSTANDING ACETALS

There are two general types of acetal products available for both injection molding and machining: homopolymer acetal and copolymer acetal. The difference is a chemistry change that does affect certain properties just enough that a better understanding of acetals is often helpful.

Homopolymers are plastics with molecular chains containing identical repeating units (mers) while copolymers chemically contain two different repeating units. Homopolymer acetal is most commonly associated with the resin name Delrin®, a registered trademark of E.I. DuPont. DuPont is the main manufacturer of homopolymer acetal resin. Copolymer acetal resin is domestically supplied under trade names such as Celcon® (Celanese) and Ultraform® (BASF). The chemistry is similar enough that both products are still considered acetals; however, there are some important property differences.

Mechanical Properties:
The strength and stiffness of unfilled homopolymer acetal (Delrin®) is approximately 10% to 15% greater than the copolymer acetals.

Hot Water/Steam Resistance:
Copolymer acetals exhibit substantially greater resistance to hydrolysis (degradation by hot water) and better dimensional stability, especially after prolonged exposure.

Chemical Resistance:
In general, the chemical resistance is similar, but may be different depending on the chemical, use temperature, and concentration. Copolymer acetal offers better resistance to chlorine-containing solutions. Common sanitizing solutions would include bleach and strong alkalies.

Continuous Service Temperature:
The continuous service temperatures for both grades are considered the same (180°F). Copolymer acetal has been reported to resist thermal degradation at higher temperature better than homopolymer acetal. However, the higher heat deflection temperature of homopolymer acetal indicates it will exhibit greater mechanical properties during short-term exposure.

Machinability:
The machinability of acetal products is extremely good. The greater stiffness of Delrin® homopolymer acetal makes it superior for screw machined parts and small diameter parts (< 1") machined on high speed CNC lathes. It is important to recognize the relevance of the extrusion processing sequence. The stability of a stock shape during machining is the direct result of the extruder's annealing cycle.

Wear Resistance:
Wear resistance, Limiting PV and k-factor are the same for unfilled homopolymer and copolymer acetals. The enhanced bearing and wear grades each have their own wear resistant properties. Inherently, all acetals have lower abrasion resistance than nylons and polyethylenes.

Appearance:
The cross section of acetal stock shapes has long been recognized to contain microporosity along the centerline of rod and plate products. The centerline porosity is created during the extrusion of stock shapes. Characteristically, copolymer acetals yield significantly less centerline porosity, but still can exhibit interconnected micro-porosity ranging from 100 to 150 microns (0.1 to 0.15mm) in stock shapes. This micro-porosity results in mechanical weakness and leakage of liquids and gases under pressure. Some stock shape manufacturers of copolymer acetal claim zero centerline porosity. Regardless, it is far superior compared to the porosity inherent in homopolymer acetal.

BOEDEKER PLASTICS

ACETAL RESINS AND EXTRUDED STOCK SHAPES

Co-Polymer Acetal:

There are numerous raw material resin sources of co-polymer acetal. Most stock shape extrusion converters carefully and strategically select high quality resin and converts them into stock shapes with individual specific tradenames, such as Acetron® GP POM-C from Mitsubishi Chemical Advanced Materials. This co-polymer acetal is known for its low center-line porosity and very low internal stress for improved machineability of fabricated parts.

Homo-Polymer Acetal Resins:

Aside from traditional Delrin® 150 POM-H resin, traditional extrusion converters of stock shapes also offer some specialty grades of Made-to-Order (MTO) homo-polymer acetals based on other Delrin® resins. However, some resin grades are not ideal for extruded stock shapes based on various fillers and viscosities which were designed for injection molded parts. Please inquire with Boedeker Plastics for any of the following formulations.

DuPont the raw material resin manufacturer of homo-polymer acetal classifies resins according to the following types:

Extrusion Grades:
The grades designated as extrusion grades for the stock shape market are higher viscosity resins specifically formulated for maximum strength and stiffness required for extruded shapes. Delrin® 150 is essentially the grade of choice for extruded shapes.

Injection Molding Grades:
The following low to medium viscosity resins are almost always used for the injection molding process. There are some exceptions and some of these can be extruded typically via a made-to-order effort.

General Purpose Grades:
These low to medium viscosity resins include Delrin® 100, 500, 900, and 1700. These resins are designed for injection molding. Delrin® 100 is the most viscous for easy to fill molds, while Delrin® 1700 is the most fluid for specialty purpose molding.

General Performance Grades:
These low to medium viscosity resins contain an additive to improve thermal stability and enhance processability during injection molding. These resins include Delrin® 100P, 500P, 900P, and 1700P.

Enhanced Crystallinity Grades:
These grades offer improved crystallinity for improved CREEP and fatigue resistance. These resins include Delrin® 111P, 311P, and 511P.

Toughened Grades:
These tough high viscosity grades are for injection molding and include Delrin® 100ST (Super Tough), 100T, and 500T.

Low Emission Toughened Grades:
These injection molding grades offer very low VOC emissions for automotive applications and include Delrin® 100STE, 100TE, 300TE, and 500TE.

UV Stabilized Grades:
These grades are designed for added resistance to UV degradation for outdoor use. They contain a chemical UV stabilizer. These grades are Delrin® 127UV, 527UV, 927UV, and 1727UV. Delrin® 527UV is most suitable for extrusion. The other grades are typically only for injection molding.

Low Friction and Wear Grades:
These grades contain various lubrication fillers to lower the coefficient of friction and enhance the wear performance. These resins are designed for injection molding and include Delrin® 100AF, 100AL, 100KM, 500AF, 520MP, 500TL, 500AL, 500CL, 500MP, and 911AL. Only the Delrin® 100AF is designed for extrusion. A blend of Delrin® AF100 with Delrin® 100 (known as Delrin® AF Blend) is often extruded as a lower cost alternative wear grade.

Glass-filled Grades:
These grades contain glass-fiber to improve strength, stiffness, and stability and include Delrin® 570, 510GR, and 525GR.

Typical Stock Shape Property Comparison:

Property	Test Method	**Acetal Copolymer POM-C**	Acetal Homopolymer POM-H (Delrin® 150)	POM-H Delrin® 500/550	POM-H Delrin® 527 UV
Tensile Strength, psi	ASTM D638	9,500	11,000	10,000	10,000
Tensile Elongation, %	ASTM D638	30	30	15	15
Tensile Modulus, psi	ASTM D638	400,000	450,000	450,000	450,000
Rockwell Hardness, R	ASTM D785	R120	R122	R120	R120
Heat Deflection Temperature (264psi), °F	ASTM D648	220	250	270	270
Continuous Use Temperature, °F		180	180	180	180
Specific Gravity	ASTM D792	1.41	1.41	1.42	1.42