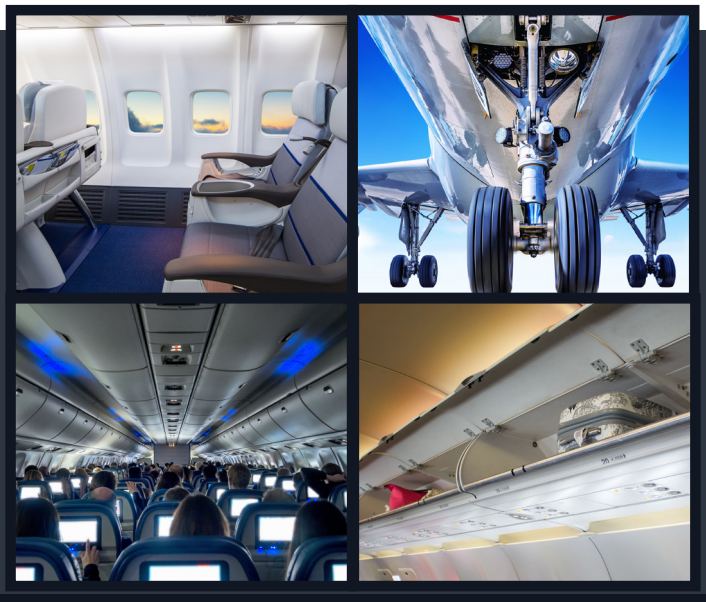
iapd
the performance plastics association

AEROSPACE

Performance plastics are used in numerous aerospace applications to improve safety, reduce costs, save fuel and improve passenger comfort.

APPLICATIONS

- Landing gear components
- Electrical and thermal insulators
- Transparency to electromagnetic signals
- Windows, canopies, dust covers
- Interior wall panels and luggage compartments
- Ventilation ducting and seals
- Trays and tray tables
- Pipes and tubing
- Fasteners
- Mirrors
- Wiring conduits
- Bushings and bearings
- Seals
- Collapsible air duct ribs



ADVANTAGES MAY INCLUDE

- Lightweight
- Reduced maintenance
- Design flexibility (colors, textures)
- Thermoformability
- Corrosion resistant
- Chemical and impact resistant
- Good insulator
- Easily fabricated
- Broad range of being temperature resistant
- Flame, smoke and toxicity resistant

MATERIALS

- Acetal (POM)
- Acrylic (PMMA)
- Acrylonitrile-Butadiene-Styrene (ABS)
- Fluorinated Ethylene Propylene (FEP)
- Perfluoroalkoxy (PFA)
- Polyamide (PA)
- Polyamide-Imide (PAI)
- Polyarylsulphone (PAS)
- Polycarbonate (PC)
- Polyetheretherketone (PEEK)
- Polyetherimide (PEI)
- Polyethylene (PE)
- Polyimide (PI)
- Polyphenylene Oxide (modified PPO)
- Polyphenylene Sulfide (PPS)
- Polytetrafluroethylene (PTFE)
- Polyvinyl Chloride (PVC)/Acrylic
- Thermoset Composites (phenolics)

DID YOU KNOW?

Thanks to performance plastics, the Airbus Extra Long Range (XLR) series will burn fuel per passenger at a rate comparable to that of an economical family car or better.

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AEROSPACE

SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS

By transitioning to high-performance polymers, which have a density of about 1.3 g/cm^3, compared to a density of 2.7 g/cm^3 for aluminum, operators can reduce weight for parts by

(source: https://thisisplastics.com/innovation/plastics-help-fortify-aviation-aerospace/)

For each pound of weight reduced on a plane:

$1,000

is saved in fuel over the life of the airplane.

(source: www.craftechind.com/why-the-aerospace-industry-loves-plastic-materials/)

15,000

gallons of fuel per year is saved.

(source: www.polymershapes.com/application/aerospace/)

By converting all metal parts, mechanical and interior, to plastic alternatives, overall cost savings could amount to as much as

50%

Operators that replace aluminum with plastic alternatives could save up to **60%** within this category of parts.

(source: https://thisisplastics.com/innovation/plastics-help-fortify-aviation-aerospace/)

In one application, **900** lightweight seats saved more than **730** tons of CO_2, the equivalent of **3,000** trees.

(source: https://runwaygirlnetwork.com/wp-content/uploads/2020/01/Mirus-scaled.jpg)

AGRICULTURE

Do you want longer-lasting parts on your machinery that require less horsepower to run and are so quiet they don't bother the animals? Look no further than performance plastics for your agricultural needs.

APPLICATIONS

- Tanks (water, chemical, fuel)
- Kickplates (interior horse trailer walls, ladder bases)
- Chutes (linings, troughs, pivots)
- Panels (shields, shrouds, side panels, roof components)
- Pipe (slurry material distribution, watering systems)
- Feeders (livestock and poultry feed bins, drinking systems)
- Irrigation (pipe, valves, nozzles, bearings)
- Planting/harvesting (seed boxes, bearings/bushings, slide pads)
- Covers (cultivator shanks, tanks, hoppers, storage bins, skid plates)
- Augers (flight facings, linings, drag plates)
- Seals (bucket elevators, bearings, spray systems, oil/fuel systems)
- Bushings, bearings, cams, gears, tensioners
- Skid plates, plowshares, feeder tubes, wear strips
- Partitions/skylights (barns, greenhouses, poultry, bins, dairy farms, sheds, kennels, workshops, roofing systems)

ADVANTAGES MAY INCLUDE

- Lightweight (easier to handle, store and less expensive to ship)
- Easier to machine and install
- Corrosion resistant (eliminates rust and special corrosion coatings)
- Excellent insulating properties
- Excellent strength-to-weight ratios
- Outstanding toughness and impact resistant
- Reduction/elimination of external lubrication possible
- Many materials are recyclable
- Excellent cost-performance ratio
- Improves product flow, less sticking and "carry-back," less product damage
- Excellent light transmission
- Various tints available
- Shatter resistant
- Reduced coefficient of friction (especially self-lubricating grades)
- Reduced or eliminated "stick-slip"
- Reduced wear on mating parts
- Longer wear life
- Fire and UL listed grades available
- UV inhibited grades (reduces premature disposal of parts)
- Antistatic grades (prevent fires and explosions due to static discharge)
- Sound-deadening properties reduce need for ear protection

MATERIALS

- Acetal (POM)
- High-Density Polyethylene (HDPE)
- Nylon (PA)
- Polycarbonate (PC)
- Polyvinyl Chloride (PVC)
- Polyvinylidene Fluoride (CPVC)
- Polytetrafluoroethylene (PTFE)
- Ultra-High Molecular Weight Polyethylene (UHMW)

DID YOU KNOW?

Agricultural products are being recycled into "plastic wood" and numerous other secondary products, keeping those materials out of landfills, creating demand for recycling plants and making farms more sustainable.

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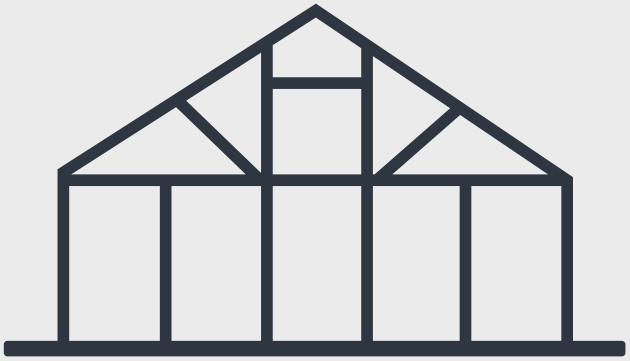
AGRICULTURE

SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS



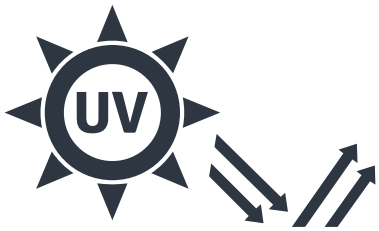
Greenhouses made with performance palstics increase yields by

2x

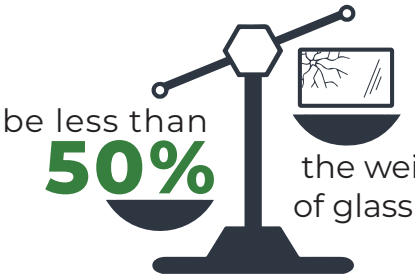
and extend the growing season, so farmers can produce more food on less land.

(source: https://ocj.com/2020/11/agricultural-plastic-in-the-u-s-and-china-a-blessing-or-a-curse/)

Corrugated polycarbonate sheet used in skylight, sidelight and roofing applications (for example, in greenhouses and barns) can:



BLOCK 99.9%
of harmful UV radiation



be less than **50%** the weight of glass

allow up to **90%** light transmission

Using this sheet to daylight barns means that there isn't a need to provide electricity, reducing the farmers' carbon footprint.

(source: www.palram.com/us/product/sunsky-polycarbonate-corrugated-sheets/)

Using plastic mulch can increase yield and water use efficiency by **25%** and allow for farming in areas that would otherwise be too dry or cold to grow food.

(source: https://ocj.com/2020/11/agricultural-plastic-in-the-u-s-and-china-a-blessing-or-a-curse/)

ALTERNATIVE ENERGY

Performance plastics play an important role in the production of solar, wind, wave, biofuels, geothermal and hydrogen equipment components.

APPLICATIONS

- Films for solar collectors
- Solar array pivot bearings
- Thrust washers
- Electrical insulators
- Housings/shrouds
- Rotational bearings, bushings
- Equipment braces
- Storage tanks
- Pipe, valves, fittings
- Standoff heat insulators
- Tubing

ADVANTAGES MAY INCLUDE

- Lightweight for more efficient operations
- Ease of fabrication
- Easy to install/replace
- Recyclable
- Corrosion and chemical resistant
- Abrasion resistant
- Impact and fatigue resistant
- Stiffness
- Excellent bearing and wear performance
- Low moisture absorption
- Weatherability
- Low creep
- Low warpage
- Solid color, eliminating painting

MATERIALS

- Acetal (POM)
- Acrylonitrile-Butadiene-Styrene (ABS)
- ABS/Polycarbonate
- Long Fiber Reinforced Thermoplastics (LFRT)
- Nylon (PA)
- Polyamideimide (PAI)
- Polybutylene (PBT)
- Polycarbonate (PC)
- Polyetheretherketone (PEEK)
- Polyethylene (PE)
- Polyethylene Terephthalate (PET)
- Polyphenylene Oxide (PPO)
- Polypropylene (PP)
- Polyurethane (PUR)

DID YOU KNOW?

We've come a long way from old-fashioned wind mills. Today, turbines as tall as skyscrapers—with turbines nearly as wide in diameter—stand at attention around the world.

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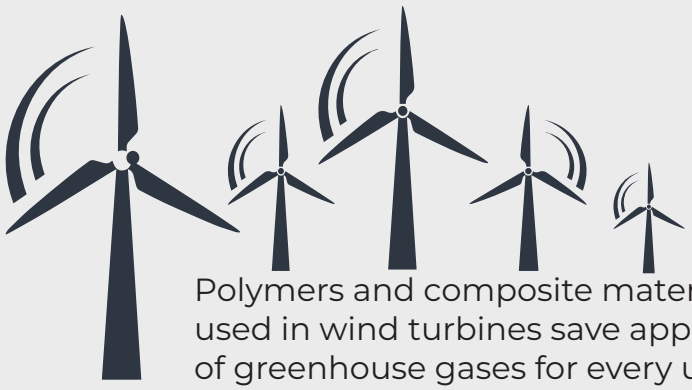
ALTERNATIVE ENERGY

SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS



Polymers and composite materials used in wind turbines save approximately **123 Units** of greenhouse gases for every unit emitted to make them.

(source: www.americanchemistry.com/chemistry-in-america/chemistry-sustainability/climate)

Demand for solar energy is expected to grow at an average rate of **15%** over the next **five** years.

(source: www.dupont.com/solar-photovoltaic-materials/technical-resources/innovating-with-urgency-meeting-the-worlds-growing-energy-needs.html)

Module Accelerated Sequential Testing (MAST) has shown that solar panels can last **25+ Years**

(source: www.dupont.com/solar-photovoltaic-materials.html)

A 6.8-megawatt solar park in France, spread over 50 acres, can produce:

More than **9,800** megawatt hours of electricity per year, enough to power **7,000 homes**

This solar energy offsets **2,000 tons** of carbon dioxide emissions CO_2

(source: www.dupont.com/content/dam/dupont/amer/us/en/photovoltaic/public/documents/DEC-Hanau_Energies_CaseStudy.pdf)

If we use plastics for energy recovery, we can reduce the volume of waste going to landfills by **80%**

https://2z2uy32ofddf3z9ep91ninb4-wpengine.netdna-ssl.com/wp-content/uploads/Energy-Recovery-Tile-1906x1080.jpg

AUTOMOTIVE

From mechanical parts to automotive interiors to external applications, performance plastics are driving safer, more durable, lightweight, fuel-efficient designs in today's cars.

APPLICATIONS

- Mud flaps
- Thermal and sound insulation
- Sheathing and jacketing
- Component housings
- Switches and sockets
- Connectors
- Bearings and bushings
- Gaskets, washers, spacers
- Fluid lines
- Wiring harnesses
- Power train components
- Internal transmission parts including transmission gears
- Bed liners
- Wheel well liners
- Trunk liners
- Car covers and protection panels
- Moisture barriers
- Truck trailer skirts
- Electric vehicle charging stations

ADVANTAGES MAY INCLUDE

- Lightweight for increased fuel efficiency
- Recyclable
- Corrosion, abrasion and fatigue resistant
- Wide range of stiffness, tensile strength and creep resistant
- Surface finish and appearance
- Low wear
- Low moisture absorption
- Thermoformability
- Weatherability
- High lubricity, self-lubrication, low coefficient of friction
- Low warpage
- Solid color, eliminating painting

MATERIALS

- Acetal (POM)
- Acrylonitrile-Butadiene-Styrene (ABS)
- Acrylic (PMMA)
- Long Fiber Reinforced Thermoplastics (LFRT)
- Nylon (PA)
- Polyamideimide (PAI)
- Polyetheretherketone (PEEK)
- Polybutylene (PBT)
- Polycarbonate (PC)
- Polyethylene (PE)
- Polyethylene Terephthalate (PET)
- Polypropylene (PP)
- Polyurethane (PUR)
- Polyetherimide (PEI)
- Polyphenylene Oxide (PPO)
- Polyphenylsulfone (PPS)

DID YOU KNOW?

More than 50 percent of a typical car is composed of plastics and polymer composites, but those materials account for only approximately 10 percent of vehicle weight.

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AUTOMOTIVE

SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS

Using plastics instead of alternative materials can make vehicles lighter so they require less fuel. These savings amount to

89 MILLION GALLONS

of gasoline and diesel **over the lifetime of vehicles** in North America produced in one year.

source: www.automotiveplastics.com/mobility-trends/sustainability

A lightweight front-end support bolster on 70,666 cars produced in a year **reduced the use of energy** by an amount equivalent to saving

770,000

GALLONS OF GASOLINE

over the life of those vehicles.

source: www.automotiveplastics.com/mobility-trends/sustainability

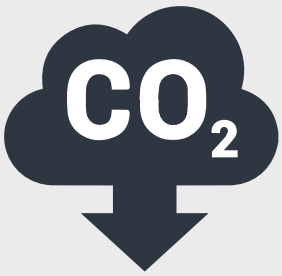
A study by the Department of Energy found that reducing a vehicle's weight by 10 percent with the help of plastic components could increase its fuel economy by **5-7%**

source: www.americanchemistry.com/chemistry-in-america/chemistry-in-everyday-products/automotive

Replacing cast iron and traditional steel components with lightweight materials such as polymer composites can reduce the weight of a vehicle's body and chassis by up to **50%**, reducing fuel consumption. Using lightweight components and high-efficiency engines enabled by advanced materials in one quarter of the U.S. fleet could save more than **5 billion** gallons of fuel annually by 2030.

source: www.energy.gov/eere/vehicles/lightweight-materials-cars-and-trucks

For every 220-pound decrease in weight of a vehicle, there will be a **3-5%** decrease in carbon emissions, depending on total vehicle size and powertrain type.



source: blog.ucsusa.org/science-blogger/lightweighting-and-fuel-economy-in-vehicles/

The 2017 ultralight automotive door used a multi-material design that included aluminum, plastic, glass fiber-reinforced plastic composite and other polymers, to achieve a **40%** mass reduction while simultaneously decreasing the lifecycle greenhouse gas emissions and primary energy demand per door by 1.5 metric tons of CO_2-eq and 21 gigajoules, respectively.

source: //blog.ucsusa.org/science-blogger/lightweighting-and-fuel-economy-in-vehicles

iapd
the performance plastics association

BUILDING/CONSTRUCTION

Maximize natural light without compromising material strength, energy savings or design possibilities with performance plastics in building applications.

APPLICATIONS

- Commercial, institutional and residential greenhouses
- Entryway canopies
- Bus shelters, specialty enclosures
- Carports
- Sloped and curved glazing
- Skylights
- Security windows, hurricane glazing and shutters
- Sound barriers
- Interior partitions, room dividers
- Lighting lenses, tubes and louvers
- Mirrors
- Furniture, benches and tables
- Corner guards and run rails
- Barrier, protective and reflective films
- Caulking and sealants
- Piping
- Wiring jacketing
- Bearing pads

ADVANTAGES MAY INCLUDE

- Lightweight for faster and safer installation
- High impact strength
- Hailstone and hurricane resistant
- Lighter than glass
- Lower freight costs than heavier materials
- High strength-to-weight ratio
- Easy to fabricate, including on-site fabrication
- Building code approved
- Fire resistant; does not give off toxic gasses
- UV resistant
- Transparent/high light transmission
- Wide range of color or tint options
- Easy to decorate
- Energy efficient; excellent thermal insulation properties
- Sustainable, can be recycled
- Chemical resistance

MATERIALS

- Acrylic (PMMA)
- Chlorinated Polyvinyl Chloride (CPVC)
- Ethylene Tetrafluoroethylene (ETFE)
- Fiber-Reinforced Plastic (FRP)
- Polycarbonate (PC), including Multiwall
- Polycarbonate
- Polyethylene Terephthalate (PETG)
- Polyvinyl Chloride (PVC)
- PVC/Acrylic Alloy (PMMA)
- Polyolefin Alloy (PO)
- Polypropylene (PP)
- Polystyrene (PS)
- Recycled Plastic Lumber
- Polyethylene (PE)
- Polyvinyl Flouride (PVC)
- Polytetrafluroethylene (PTFE)
- Perfluoroalkoxy (PFA)
- Silicone (SI)

DID YOU KNOW?

Polycarbonate (PC) has an impact strength that is 100 times stronger than glass, just one of the reasons the National Green Building Council added many plastics to the LEED Certified Building Materials list.

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BUILDING & CONSTRUCTION

SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS

CONSTRUCTION MATERIALS

The energy saved by using plastic building and construction materials compared to alternative materials is approximately **467.2 trillion BTU** of energy a year; enough to meet the average annual energy needs of **4.6 million** U.S. households.

(Source: https://www.plasticsmakeitpossible.com/plastics-at-home/home-garden/home-improvement/plastic-home-improvement-products-help-save-energy-and-reduce-waste/)

Compared to traditional building bricks, plastic building blocks emit **95%** less CO_2.

(Source: http://www.plasticseurope.org/documents/document/20121120170458-final_plasticsthefacts_nov2012_en_web_resolution.pdf)

Using recycled plastic in the construction of a 13-story residential tower saved **1,613 tons** of concrete and **136 tons** of CO_2 emissions.

(Source: https://www.marshmclennan.com/insights/publications/2021/april-/the-construction-industry-and-the-plastic-challenge.html)

While building and construction represents around **20%** of the demand for plastic materials, it currently generates only **6%** of plastic waste because of its long service life.

https://www.modernbuildingalliance.eu/environmental-sustainability-plastics-construction/

INSULATION

Plastic insulation:

- Saves more than **200x** the energy used in its manufacture.
- Consumes **16%** less energy and produces **9%** less GHG emissions than alternative materials.

(source: https://pubs.rsc.org/en/content/chapterhtml/2018/bk9781788012416-00001?isbn=978-1-78801-241-6)

Insulating foams in buildings save **2,400 million tons** of greenhouse gas in their lifetime.

Source: http://www.cia.org.uk/Portals/0/Documents/Low_carbon_brochure_final2LR.pdf

House wraps save **360 BTUs** of energy for every one BTU used to make the materials.

(Source: https://www.plasticsmakeitpossible.com/plastics-at-home/home-garden/home-improvement/plastic-home-improvement-products-help-save-energy-and-reduce-waste/)

WINDOWS/GLAZING

PVC windows last up to **40 years** and are **100% recyclable.**

(source: www.shiniusa.com/2018/01/29/recycled-plastics-construction/)

Infrared sheet grades can help maintain comfortable interior temperatures:

- Annual energy savings for cooling and heating may total **15-25%** with IR sheet when compared with double-pane glass.
- Over a year, IR sheet could save the equivalent of **$33-$53** per square meter (3.28 sq. ft.) in energy, while reducing carbon emissions.
- This contributes to an emission reduction of approximately **143,360-235,200 pounds**.

(Source: https://iibec.org/wp-content/uploads/2014-01-govers.pdf)

CHEMICAL

Chemicals easily eat through many materials, but they've met their match with performance plastics. The right plastics can ensure a safe, durable, long-lasting performance even under the harshest conditions.

APPLICATIONS

- Laboratory equipment
- Municipal water and wastewater industry piping
- Drain-waste-vent systems
- Fume hoods and ducting
- Pump and valve components
- Renal care facilities
- Pharmaceutical, biopharmaceuticals and medical research
- High purity semiconductor industry
- HPLC tubing and valve components
- Lab countertops or other processing areas
- Chemical containers, storage or retention
- Plating tanks, barrels, parts
- Safety barriers, such as eye shields, face shields
- Pulp and paper bleaching
- Metals preparation and mining
- Fuel (underground transport and holding systems)
- Gaskets, seals and spacers
- Food, dairy and beverage
- Piping
- Tank and tanker linings
- Wall linings

ADVANTAGES MAY INCLUDE

- Corrosion resistant (broad spectrum chemical resistance)
- Low friction (ease of flow)
- Resistant to a wide range of temperatures
- FDA and USDA approved
- Easy to install
- Meets flammability standards
- Ease of fabrication (machined, welded and formed)
- High purity
- Static dissipation
- Excellent strength-to-weight ratios
- Long lasting, durable
- Wide range of operating pressure/burst resistant
- Lightweight
- Able to color code to indicate contents

MATERIALS

- Alpha-Nucleated PP-DWU Twin-Wall Sheets (PP-HKP)
- Chlorinated Polyvinyl Chloride (CPVC)
- Ethylene-Tetrafluoroethylene (ECTFE)
- Fiberglass Reinforced Plastic (FRP)
- Flame Retardant Polypropylene (FR PP)
- Fluorinated Ethylene Propylene (FEP)
- High-Density Polyethylene (HDPE)
- Nylon/Cast Nylon (PA)
- Perfluoroalkoxy (PFA)
- Polyethylene (PE)
- Polyethylene, High Heat Resistant, UV Stabilized (PE-HWU)
- Polypropylene Copolymer (CPP), Homopolymer (PPH)
- Polytetrafluoroethylene (PTFE)
- Polyvinyl Chloride (PVC)
- Polyvinylidene Fluoride (PVDF)
- Polyphenylene sulfide (PPS)
- Ultra-High Molecular Weight Polyethylene (UHMW-PE)

DID YOU KNOW?

Certain thermoplastics are 100 percent inert to corrosive chemicals across the entire pH range, cutting cost, weight and maintenance in applications.

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CHEMICAL

SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS

Many chemical production facilities spend as much as **2%** of their sales on maintenance directly tied to the impact of corrosion alone. **This expense could be mitigated by the use of performance plastics.**

(source: Plastic Solutions for the Chemical Industry by Mark Kramer, IAPD article in Feb/March 2012 issue)

High purity PVDF is non-leaching and will not support growth of biological impurities, making it suitable for high and ultrapure applications.

Polyethylene has superior abrasion resistance, by using a sand-slurry method that makes it **50%** more abrasion-resistant than steel.

(source: www.processengineer.com/material-selection-for-chemical-process-equipment-plastics/)

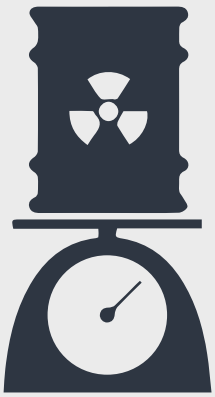
Thermoplastics are available that are **100%** inert to corrosive chemicals across the entire pH range, enabling processors and equipment manufacturers alike to preempt corrosion and contamination while significantly cutting cost, weight and maintenance.

(source: www.processengineer.com/material-selection-for-chemical-process-equipment-plastics/)

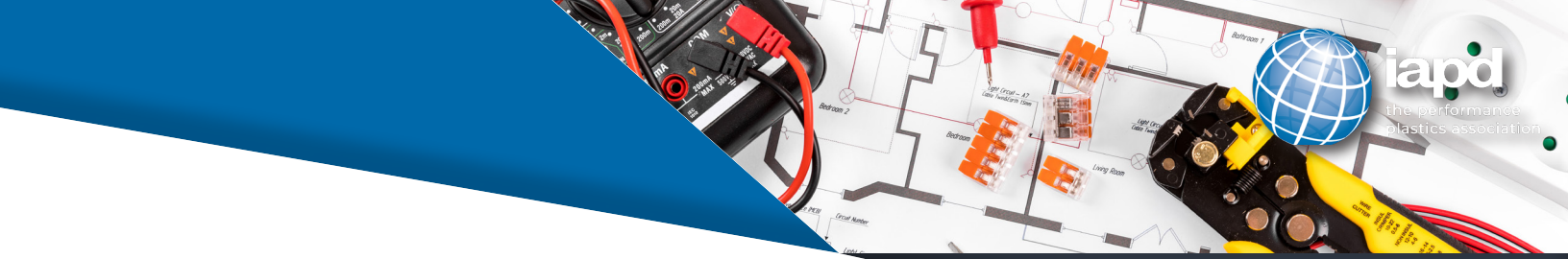
Fiberglass reinforced plastics (FRP) are lightweight (approximately **25%** the weight of steel) and typically provide approximately **50%** of lengthwise tensile and flexural strength of steel.

(source: www.processengineer.com/category/news/page/3/)

Many chemical products weigh 10 pounds or more per gallon, making the strength-to-weight ratio of performance plastics critical in their containment in smaller vessels.



(source: www.processengineer.com/material-selection-for-chemical-process-equipment-plastics/)



ELECTRICAL

There's a plastic to meet every standard and use for electrical applications. The next time you need a stable, impact-resistant, easy-to-process, safe material, think performance plastics.

APPLICATIONS

- Wire and cable insulation
- Plenum-rated wire and cable jacketing
- Arc shields
- Test boards
- Circuit boards, wiring boards
- Connectors — data, automotive, telecommunications, fiber optic
- High-voltage circuit-breaker housings
- Aircraft electrical insulators
- Radar gun lenses
- Electronic test sockets and fixtures
- Conduits

ADVANTAGES MAY INCLUDE

- Strong, high impact resistant
- Thermoformable
- Nonconductive; resistant to electricity
- Can be made static dissipative or fully conductive
- Inherently good insulator
- Chemical, UV, abrasion resistant
- Temperature resistant
- Hydrolytic stability
- Low flammability and smoke generation
- High creep resistant

MATERIALS

- Ethylene-Chlorotrifluoroethylene (ECTFE)
- Ethylene Tetrafluoroethylene (ETFE)
- Fluorinated Ethylene Propylene (FEP)
- Perfluoroalkoxy (PFA)
- Polyamide-Imide (PAI)
- Polyetheretherketone (PEEK)
- Polyetherimide (PEI)
- Polyethersulfone (PES)
- Polyimide (PI)
- Polyphenylene Ether, Modified (PPE)
- Polyphenylene Oxide (modified PPO)
- Polyphenylene Sulfide (PPS)
- Polypropylene (PP)
- Polytetrafluoroethylene (PTFE)
- Polyvinyl Chloride (PVC)
- Polyvinylidene Fluoride (PVDF)
- Styrene Maleic Anhydride-Polycarbonate (SMA-PC)
- Thermoplastic Polyesters — Polybutylene Terephthalate (PBT), Polythramethylene
- Terephthalate (PTMT), Polyethylene Terephthalate (PET)
- Thermoset Industrial Laminates — Epoxy,
- Melamine, Silicone, Polyester, Industrial
- Thermosets (Phenolics) Paper and Cotton Grades
- Vulcanized Fibre

DID YOU KNOW?

The first synthetic plastic developed for the electrical/electronics industry, Bakelite, was created to replace Shellac, a resin secreted by the female lac bug in India and Thailand.

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ELECTRICAL

SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS

Light-emitting diodes (LEDs) made with performance plastics use **75%** less energy and last up to **25x** longer than incandescent lighting.

(source: www.energy.gov/eere/ssl/led-adoption-report)

Average smartphone users reach for their phones up to **150x Each Day** — with the potential for hours of device-to-skin exposure. To meet this reality, companies are responding with designs and materials that create durable electronics with extra longevity and sustainable value.

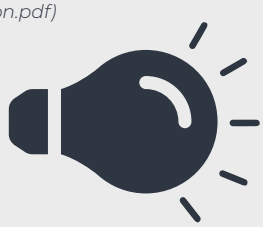
(source: www.eastman.com/Markets/Consumer-Electronics/Device-Housings/Pages/Protective-Cases.aspx)

Using recycled plastic in an electrical/electronic product could reduce the environmental impact of a single product by more than **20%**

(source: https://circulareconomy.europa.eu/platform/sites/default/files/designing_plastics_circulation.pdf)

Recycling one plastic bottle can save enough energy to power a **60W** light bulb for **6 hours.**

(source: https://repository.upenn.edu/cgi/viewcontent.cgi?article=1030&context=psr)



75% of consumers say they would pay more for devices made with sustainable materials.

(source: www.eastman.com/Markets/Consumer-Electronics/Device-Housings/Pages/Protective-Cases.aspx)

If all waste electrical and electronic equipment plastics in Europe were recycled, estimated CO_2 emission reductions would be more than **2.5 million** metric tons per year.

(source: https://circulareconomy.europa.eu/platform/sites/default/files/designing_plastics_circulation.pdf)

Covering electrical wires in plastic guarantees that the electrons flowing through the wires will not flow through your body when the wire is touched. Studies show that only **.05 amps** of electric current can cause heart attack and skin damage and high probability of death. The service coming to an ideal house in the U.S. is rated at **200 amps**

(source: https://www.quora.com/Why-do-electrical-wires-have-plastic-coverings)

ENVIRONMENTAL

Not only do performance plastics have a low overall lifecycle carbon footprint, including being recyclable, they are used directly in applications that help preserve and restore the world in which we live.

APPLICATIONS

- Waste water system components
- Drinking water and sewage system flow control components
- Desalinization plant system components
- Pollution control scrubbing and piping components
- Landfill vent pipes
- Compost containers
- Trash truck components
- Construction, heavy equipment and transportation “lube free” wear components
- Incineration and storage conveyor components
- Clean water well exploration and production components
- Solar energy system components
- Biofuel cultivation, harvesting and processing components
- Fuel cell manifolds

ADVANTAGES MAY INCLUDE

- Strength
- Toughness
- Chemical, moisture and heat resistant
- Ease of processing and forming
- Ease of sealing
- Lighter and less expensive to manufacture than metal
- Transmits over 90 percent of light, yet is resistant to UV
- Weather resistant
- Recyclable
- Immune to electrolytic and galvanic corrosion, scaling, rusting and pitting
- Resistant to abrasion, bacteria and fungi
- Less frequent maintenance and replacement
- Less costly to transport and install
- Water conservation via fewer water main breaks
- High aesthetic appeal

MATERIALS

- Bioplastics
- Cast Nylon (PA)
- Chlorinated Polyvinyl Chloride (CPVC)
- High-Density Polyethylene (HDPE)
- Low-Density Polyethylene (LDPE)
- Polybutylene Terephthalate (PBT)
- Polycarbonate (PC)
- Polyethylene Terephthalate (PET, PETE)
- Polypropylene (PP)
- Polystyrene (PS)
- Polyvinyl Chloride (PVC)
- Polyetherimide (PEI)
- Polyethylene Terephthalate (PET)
- Plastic grates and walkways

DID YOU KNOW?
IAPD members are environmentally conscious: 91 percent have a company-wide sustainability program.

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ENVIRONMENTAL

SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS

One ton of recycled plastic saves:

5,774 Kwh
of energy

16.3
barrels of oil

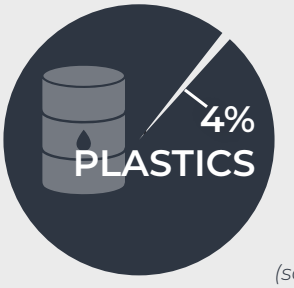
98 million
BTUs of energy

30 cubic yards
of landfill space

(source: https://lbre.stanford.edu/pssistanford-recycling/frequently-asked-questions/frequently-asked-questions-benefits-recycling)

According to the Environmental Protection Agency, recycling a ton of plastic conserves about **3.8 barrels** of crude oil.

(source: www.fastenercomponents.com/news/incredible-facts-about-plastic/)



Plastics consume just **4%** of oil production.

They take less energy — and therefore less fossil fuel — to make than most traditional materials. This makes them cheaper to make and buy, as well as benefitting the environment by conserving resources.

(source: https://daiaplastic.com/en/plastics-in-electrical-and-electronic-applications/)

Plastics capture **50%** of the carbon that is used to produce them.

(source: www.ncbi.nlm.nih.gov/pmc/articles/PMC2873019/)

In addition to diverting plastics from landfills, advanced recycling technologies **emit fewer emissions than other traditional recycling methods**.

Pyrolysis can **reduce CO_2 emissions** by about **50%** compared to incineration of the same materials.

According to a study by Argonne National Laboratory, making ultra-low sulfur diesel fuel from used plastics could **decrease the consumption of water by 58% and the use of traditional energy sources by 96%** compared to producing the product from traditional materials.

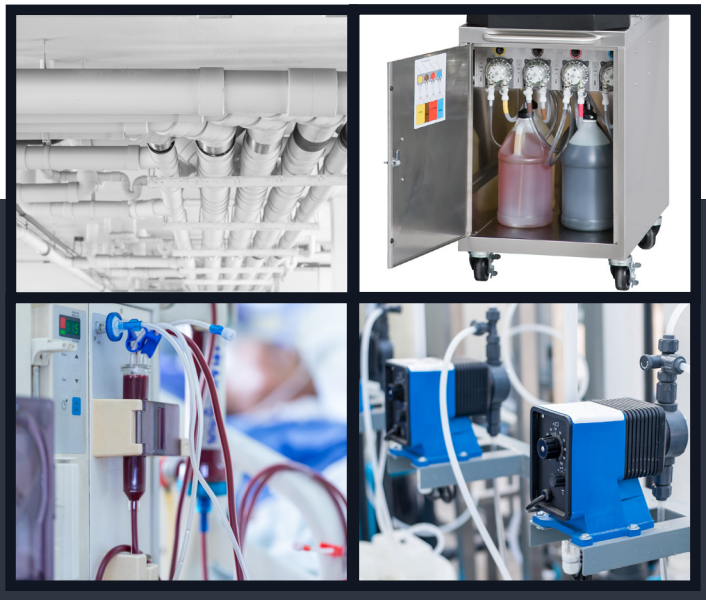
(https://2z2uy32ofddf3z9ep91ninb4-wpengine.netdna-ssl.com/wp-content/uploads/Advanced-Recycling-Technologies-Infographic.pdf)

FLUID HANDLING

How do you ensure that your lab, semiconductor or food processing applications won't be contaminated by materials in transport? It's easy ... use performance plastics!

APPLICATIONS

- Clinical and diagnostic — sampling, reagent transfer, dialysis, blood processing, washing
- Pharmaceutical industry
- Food processing and dispensing equipment
- Chemical process industry
- Semiconductor fabrication
- Ultra high purity fluid storage, transport, monitoring, control
- High performance liquid chromatography (HPLC) components
- Line tanks and transport vessels
- Manifolds, fittings, valves
- Municipal water and wastewater treatment
- Potable water treatment
- Pumps, valves
- Wafer carriers
- Industrial wastewater treatment
- Heat exchangers



ADVANTAGES MAY INCLUDE

- Low coefficient of friction
- High flexibility
- Outstanding temperature stability
- Chemical resistant
- Low gas and vapor permeability
- Corrosion resistance
- Smooth inner walls for a fluid flow path with no dead spots or crevices
- Meets high purity and high hygiene requirements
- Can be cleaned and sterilized using clean-in-place (CIP) or sanitize-in-place (SIP) methods
- Nonreactive with a wide variety of chemicals
- Does not contain impurities that can leach into the fluid stream
- Will not absorb contaminants
- Wide variety of pressure ratings
- Clarity — ability to monitor flow

MATERIALS

- Acrylic (PMMA)
- Chlorinated Polyvinyl Chloride (CPVC)
- Ethylene-Chlorotrifluoroethylene (ECTFE)
- Fluorinated Ethlyene Propylene (FEP)
- Nylon (PA)
- Perfluoroalkoxy (PFA)
- Polyetheretherketone (PEEK)
- Polyethylene (PE)
- Polypropylene (PP)
- Polytetrafluoroethylene (PTFE)
- Polyurethane (PU/PUR)
- Polyvinyl Chloride (PVC)
- Polyvinylidene Fluoride (PVDF)

DID YOU KNOW?

Hundreds of tons of pollutants are washed into our watercourses every year. Secure, reliable, efficient water filtration systems prevent such impurities reaching our taps and keep our drinking water clean and healthy to drink.

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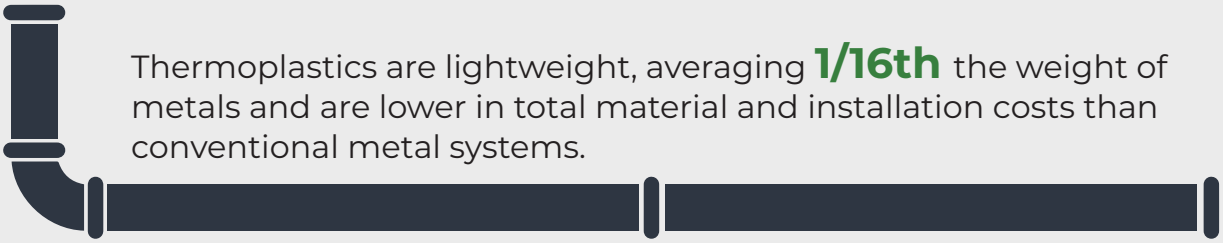
FLUID HANDLING

SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS



Thermoplastics are lightweight, averaging **1/16th** the weight of metals and are lower in total material and installation costs than conventional metal systems.

(source: https://lbre.stanford.edu/pssistanford-recycling/frequently-asked-questions/frequently-asked-questions-benefits-recycling)

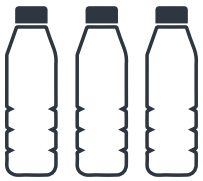
When used in pumps, valves and fittings, performance plastics have a **6x** longer useful life compared to metal.

(source: www.sme.org/technologies/articles/2014/october/change-up-pitch-from-metal-to-plastic/)

The latest innovations in antimicrobial plastic can reduce bacteria by up to **99.99%**

https://www.avomeen.com/lifesciences-benefits-plastic-medical-industry/

Packaging beverages in PET versus glass or metal reduces energy consumption by **52%** and greenhouse gas emissions by **55%**



https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2873019/

A plastic 2 fl. oz bottle may weigh only .023 lbs. while its glass counterpart weighs .177 lbs. Glass manufacturing is energy-intensive, accounting for **1%** of total industrial energy use in an Energy Information Administration survey of the manufacturing sector. Natural gas fuels most of this energy. Glass makes up **5%** of the garbage in the United States, meaning that even though it is recyclable, it often gets landfilled.

https://aipprecision.com/the-advantage-of-plastics-over-metals-for-custom-parts/

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FOOD & BEVERAGE

Performance plastic materials are used in a variety of food processing and packaging machinery applications including friction and wear parts. Plastic tubing/piping is to handle fluids. Plastic sheet materials are used for safe, easy-to-clean cutting boards.

APPLICATIONS

- Bushings, bearings, cams
- Conveyor parts
- Feed screws
- Guide rails
- Machine guards, windows
- Pipes and tubes for fluid processing
- Pistons/plungers
- Rollers
- Seals, seats, gaskets
- Gears, sprockets
- Star wheels
- Thermoformed machine housings
- Wear strips
- Forming dies
- Scraper blades
- Cams and cam guides
- Nozzles/dispensing heads

ADVANTAGES MAY INCLUDE

- Lightweight for high-speed production using smaller drive motors
- Reduced maintenance and reduced contamination by eliminating lubrication
- Resistance to clean-in-place (CIP) and sanitize-in-place (SIP) cleaning chemicals
- Resistant to hot water and steam
- Long wear life
- Limited wear on food packaging and/or mating machine parts
- Transparency for easy viewing of machine during operations
- Grades are available that comply with FDA, NSF, 3A dairy and other federal agency regulations

MATERIALS

- Acetal (POM)
- Acrylic (PMMA)
- High-Density Polyethylene (HDPE)
- Nylon (PA)
- Polycarbonate (PC)
- Polyethyleneterephthalate (PET)
- Polyetheretherketone (PEEK)
- Polyetherimide (PEI)
- Polyamide-Imide (PAI)
- Polypropylene (PP)
- Polyvinyl Chloride (PVC) – rigid and flexible
- Polytetrafluroethylene (PTFE)
- Ultra High Molecular Weight Polyethylene (UHMW-PE)
- Visual and Metal detectable materials available

DID YOU KNOW?

PTFE, one of the first plastics used in food processing, was discovered by accident. DuPont engineers were experimenting with TFE as a new refrigerant, but when the gas was stored in cylinders it polymerized into PTFE resin.

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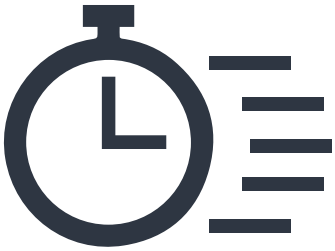
FOOD & BEVERAGE

SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS

Polycarbonate is **30x** stronger than acrylic and more than **200x** stronger than glass. It is a long-lasting choice of material for conveyor systems in the food processing industry.

(source: www.piedmontplastics.com/markets/food-processing-and-handling)

Performance plastics allow for **85%** weight reduction when compared to metals, allowing for higher processing speeds.



(source: www.mcam.com/en/industries/food-pharma)

Self-lubricating materials means **ZERO** need for additional lubrication, which could be harmful to the environment.

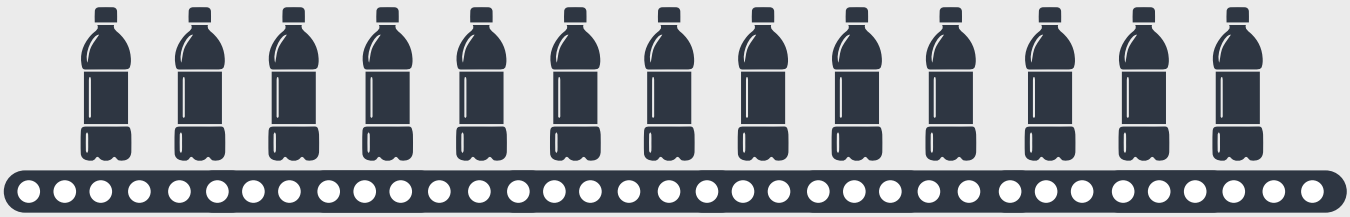
(source: www.mcam.com/na-en/industries/food-beverage/vmx-portfolio/)

In 2012 Planters switched from glass to plastic for their line of peanut products and reduced shipping weight by a whopping **84%!**

(source: https://packagingoptionsdirect.com/glass-vs-plastic-packaging)

Plus, **24%** fewer trucks are needed for transportation.

(source: www.environmentalleader.com/2012/04/planters-cuts-peanut-jar-weight-by-84/)



A bottling company converted the bushes and lifting rollers in their bottle filling machines to a dry running line with performance plastics, saving **95,000** gallons of water per year.

(source: Performance Plastics Save Company 95,000 Gallons of Water Annually, Performance Plastics magazine, October/November 2020)

HEAVY EQUIPMENT

Despite the extremely heavy loads and challenging work environments of most heavy equipment, performance plastics over performance superior to many traditional materials in vital applications.

APPLICATIONS

- Bushings and bearings
- Wear pads
- Sheaves
- Guides for electrical and hydraulic lines
- Rollers
- Liners
- Chutes
- Seals
- Outrigger pads
- Slide bars/cam actuators
- Cushion pads (pile-driving equipment)
- Guards and fenders
- Glazing (windows)
- Grating
- Stairs

ADVANTAGES MAY INCLUDE

- Lightweight
- Corrosion resistant
- Low friction
- High wear resistant
- High impact resistant
- No external lubrication required
- Reduced wear on mating parts
- Ease of installation and assembly
- Low conductivity, thermally and electrically
- High strength
- Dimensional stability
- Wide service temperature range
- Reduced maintenance cost

MATERIALS

- Acrylic (PMMA)
- Fiberglass Reinforced Polymers (FRP)
- High-Density Polyethylene (HDPE)
- Nylon (PA)
- Polycarbonate (PC)
- Polyethylenterepthalate (PET)
- Ultra-High Molecular Weight Polyethylene
- (UHMW-PE)

DID YOU KNOW?

Self-lubricating performance plastic wear parts can reduce or eliminate lubricant “wash-out” in heavy equipment bearing applications, greatly reducing non-point source pollution that seeps into the groundwater.

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HEAVY EQUIPMENT

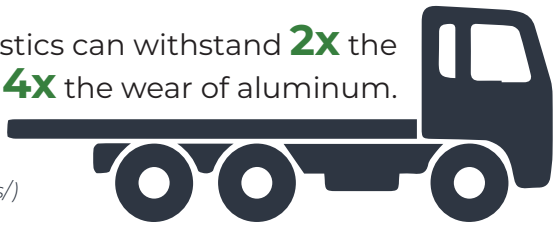
SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS

Heavy-duty trucks make up the second largest vehicle segment and produce around **20%** of the greenhouse gas emissions in America. Performance plastics, which are **1/7** the weight of steel, can significantly lighten the load and help to meet fuel efficiency goals, which will:

- Reduce CO_2 emissions by approximately **11 billion metric tons**
- Save **$170 billion** in fuel costs
- Reduce oil consumption by **2 billion** barrels over the lifespan of the vehicles sold
- Provide **$230 billion** in societal net benefits
- Increase climate quality and improve health

(source: www.automotiveplastics.com/blog/plastics-heavy-duty-trucks-meet-new-fuel-efficiency-standards/)

Truck liners made from performance plastics can withstand **2x** the wear of steel and **4x** the wear of aluminum.



(source: www.redwoodplastics.com/materials/truck-liners/)

Outrigger pads made from performance plastics are **1/7th** the weight of steel, can withstand loads up to **3,000 psi** and can withstand more than **1,000,000 pounds** of compressive load.

(source: www.redwoodplastics.com/materials/outrigger-pads/)

Thermoplastic parts are up to **40%** lighter than fiberglass, **6x** lighter than stainless steel and are **1/2** the weight of aluminum. Lightweight material equates to higher fuel or battery efficiency and reduced maintenance costs.

(source: www.productiveplastics.com/industrial/)

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LIFE SCIENCES

Life sciences applications demand durability, reliability, regulatory compliance, traceability from raw materials and design flexibility. What's the Rx for life sciences' needs? Performance plastics, of course!

APPLICATIONS

- Tanks (water, chemical, fuel)
- Laboratory equipment — tubing, seals, hoses, optics, fluid handling
- Pharmaceutical — tablet production, packaging
- Dental — instruments, grips, drilling/ suction equipment, polishing equipment
- Medical — instruments, syringes, catheters
- Prosthetic/orthopedic appliances
- Surgical applications — minimally invasive equipment, surgical trays/ grips
- Diagnostic equipment — MRI, CAT, X-ray machines, ultrasound/ radiation equipment
- Safety equipment
- Corrosion-resistant equipment

ADVANTAGES MAY INCLUDE

- Transparency to X-rays
- Traceable from raw material to finished product
- Stable under most sterilization techniques
- Withstands a wide temperature range
- Dimensionally stable
- Resistant to corrosion and radiation
- Biocompatibility per ISO 10993-5, FDA compliant
- High impact strength
- Easy to machine
- Lightweight
- Availability in numerous colors for color-coding
- Wears well, even without lubrication
- Quieter than metal
- Comfortable feel (instrument handles are softer, warmer to the touch than metals)

MATERIALS

- Acetal Polyoxymethylene (POM)
- Acrylonitrile-Butadiene-Styrene (ABS)
- Acrylic (PMMA)
- Polyetheretherketone (PEEK)
- Polyetherimide (PEI)
- Polyethylene (PE)
- Polymethyl Pentene (PMP)
- Polysulfone (PSU)
- Polyphenylsulfone (PPSU)
- Polycarbonate (PC)
- Polypropylene (PP)
- Polyester Terephthalate Glycol Modified (PET-G)
- (PETG Copolymer)
- Polyvinyl Chloride (PVC)
- PVC/Acrylic Alloy Sheet
- Styrene Acrylonitrile Copolymer (SAN)
- Thermoplastic Elastomer (TPE)
- Ultra-High Molecular Weight Polyethylene (UHMW-PE)
- High-Pressure Laminates (HPL)
- Thermoplastic Composites (phenolics)

DID YOU KNOW?

Describing the surgery to implant the first artificial human heart, surgeon William Devries, said the new heart snapped into place "just like closing Tupperware."

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LIFE SCIENCE

SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS

Sliding plastic bearings are up to **4x** quieter than recirculating ball bearings, which is essential for labs packed with automation machines and other equipment that relies heavily on motion control products.

(source: https://toolbox.igus.com/motion-plastics-blog/7-reasons-why-plastic-bearings-be-illin-within-lab-hospital-devices)

ZERO wet lubricants are required for plastic bushings and linear bearings, which could contaminate the lab.

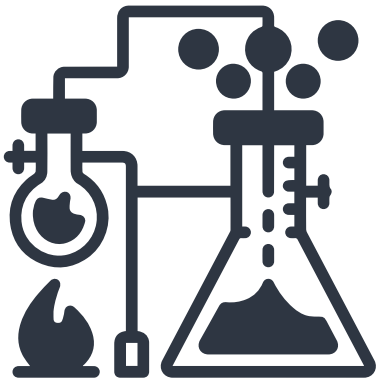
(source: https://toolbox.igus.com/motion-plastics-blog/7-reasons-why-plastic-bearings-be-illin-within-lab-hospital-devices)

Linear slides can be as small as **6 mm**, taking up little space in a lab.

(source: https://toolbox.igus.com/motion-plastics-blog/7-reasons-why-plastic-bearings-be-illin-within-lab-hospital-devices)

Laboratories consume **10x** more energy and **4x** more water than a commercial office space.

(source: https://www.aacc.org/cln/articles/2019/march/clinical-labs-making-the-switch-to-green)



Most laboratory faucets run at **4 gallons/minute** even though most standard faucets are equipped with low-flow aerators, inexpensive devices that restrict the flow of water to **1.5 gallons/minute** or less. By simply installing low-flow aerators (all plastic), labs can save thousands of gallons per year.

https://www.aacc.org/cln/articles/2019/march/clinical-labs-making-the-switch-to-green

LUMBER

Lumber and paper processing operations that use performance plastics instead of metal parts have longer wearing, less noisy, more reliable equipment that performs better. Clearly, plastics are a cut above the rest!

APPLICATIONS

- Lumber industry — saw tables, liners, hose wrap/saddles, bushing, bearings, rollers, sprockets, chain guides, safety windows, flange caps, wear rails, saw guides
- Saw mills and planer mills — tipple gates, chain channel inserts, wear plates/strips, bearings/blocks, sound dampeners, chipper spouts, drop grate arms, conveyor flights, hooks, slider blocks, diverter arms, chain caps, chip screens
- Pulp and paper industry — bearings, bushings, conveyor parts, sprockets, liners, seals and rings, deflector blades, forming boards, pulp bale press slides and protectors, paper wedges
- Protects hoses, wires and cables from rubbing, crushing and kinking

ADVANTAGES MAY INCLUDE

- Cost efficient
- UV and weather resistant
- Reduced noise and vibration
- Self-lubricating
- Wide temperature resistant range
- Easy to install and replace
- Faster flow over screens
- Fewer hang-ups
- Lightweight
- Low coefficient of friction
- Lighter than steel; outlasts rubber
- Requires less power to operate
- Handles pressure and friction well
- Impact and abrasion resistant
- Minimizes product damage
- Shock absorbing
- Extends equipment life
- Corrosion resistance to corrosion, rotting, rusting

MATERIALS

- Acetal (POM)
- Chlorinated Polyvinyl Chloride (CPVC)
- Fluorinated Ethylene Propylene (FEP)
- High-Density Polyethylene (HDPE)
- Low-Density Polyethylene (LDPE)
- Nylon/Cast Nylon (PA)
- Polycarbonate (PC)
- Polyurethane (PU/PUR)
- Polyethyleneterpthalate (PET)
- Polytetrafluoroethylene (PTFE)
- Thermoset Polyesters and Phenolics
- Ultra-High Molecular Weight Polyethylene (UHMW-PE)

DID YOU KNOW?

Structural plastic lumber has been used to make about 1.5 million railway ties in the United States alone. Since each tie weighs about 200 pounds, that means roughly 300 million pounds of plastics have not ended up in landfills, won't choke marine life and won't soil beaches.

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LUMBER

SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS

Cast nylon requires approximately **75%** less lubrication and has a longer chain life than other materials when used in chain beds and liners in sawmills.

(source: www.nylatech.com/cast-nylon-sawmill-equipment/)

Plastics outwear materials such as bronze and Babbitt by **2-4x** in applications such as wear guides, bushings, sprockets and more, improving productivity and reducing downtime.

(source: www.4sawmills.com/applications/page/10/)

Sprockets made from performance plastics are up to **50%** lighter and significantly quieter than comparable steel sprockets.

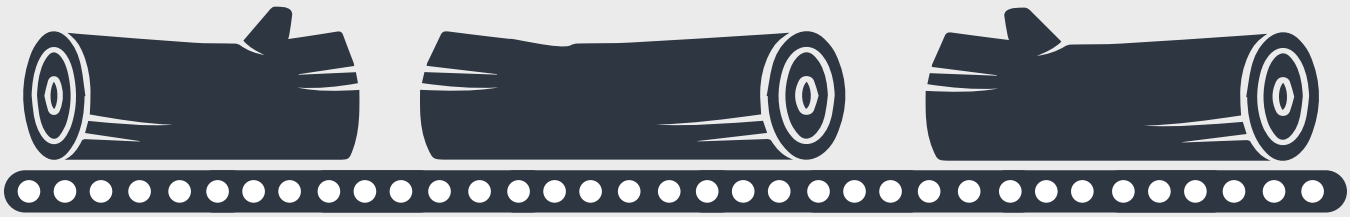
(source: http://redwoodplastics.com/wp-content/uploads/2021/Forestry-Sawmill-Biomass-PulpPaper-03-2021.html)

With a low coefficient of friction, superior abrasion and corrosion resistance, UHMW has been proven to outlast mild and hardened steel by as much as **10:1**

(source: http://redwoodplastics.com/wp-content/uploads/2021/Forestry-Sawmill-Biomass-PulpPaper-03-2021.html)

Polyurethane offers remarkable abrasion resistance and outstanding durability in shock, vibration and impact applications, outlasting rubber and metals by up to **20:1**

(source: http://redwoodplastics.com/wp-content/uploads/2021/Forestry-Sawmill-Biomass-PulpPaper-03-2021.html)



A UHMW tang conveyor flight is **50%** the weight of cast steel.

(source: http://redwoodplastics.com/wp-content/uploads/2021/Forestry-Sawmill-Biomass-PulpPaper-03-2021.html)

Nylon sheaves are **¼** the weight of steel, offer load bearing capabilities up to **4,000 psi** and compressive strength of **15,000 psi**

(source: http://redwoodplastics.com/wp-content/uploads/2021/Forestry-Sawmill-Biomass-PulpPaper-03-2021.html)

MARINE

Performance plastics are resistant to saltwater, UV, chemicals, sunshine and corrosion, making them perfect for marine applications.

APPLICATIONS

- Tanks (water, chemical, fuel)
- Fuel lines
- Cowls
- Fairings
- Fishing rod holders and racks
- Boat and dock bumpers
- Pulleys and sheaves
- Switch board panels
- Relay bases
- Rudder and stern shaft bearings
- Deck machinery bushings and linear bearings
- Pump bearings
- Cabinetry
- Swim platforms
- Grab rails and handles
- Decking
- Gangways and steps
- Windows
- Sealing

ADVANTAGES MAY INCLUDE

- Lightweight (easier to handle, store and less Stable and rigid
- Saltwater, UV, weather, chemical, odor and stain resistant
- Low coefficient of thermal expansion
- Increases hydrodynamics
- Complex, sculpted contours; easy to fabricate
- Superior flatness, doesn't warp or delaminate
- Flexible, bends without breaking
- Non-conductive
- Available in many colors
- Lightweight
- No painting required
- Cleans easily
- Low moisture absorption
- Excellent bearing and wear performance
- Does not rot, swell or splinter

MATERIALS

- Acrylic (PMMA)
- Acrylic-Styrene-Acrylonitrile (ASA)
- Acrylonitrile-Butadiene-Styrene (ABS)
- Cellulosics
- Epoxy
- High-Density Polyethylene (HDPE)
- Ionomer
- Nylon/Cast Nylon (PA)
- Phenolic (Industrial Thermosets)
- Polybutylene Terephthalate (PBT)
- Polycarbonate (PC)
- Polycarbonate/Acrylonitrile-Butadiene-Styrene (PC/ABS)
- Polyethylene Terephthalate (PET)
- Polyurethane (PU/PUR)
- Polyvinyl Chloride (PVC)
- Silicone (SI)
- Thermoset Polyesters
- Ultra-High Molecular Weight Polyethylene (UHMW-PE)

DID YOU KNOW?

In Canada, fishing is more popular than golf and tennis combined, according to the Canadian Safe Boating Council.

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MARINE

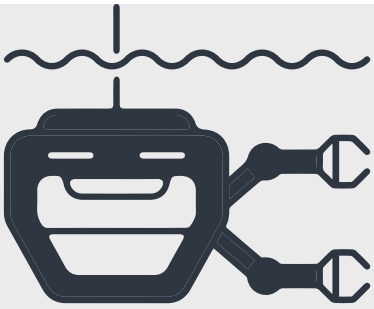
SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS

100% recycled HDPE plastic lumber was used to replace the dock in Santa Cruz, CA USA after it was damaged by a tsunami. The new dock has a **50-year warranty**.

(source: https://tangentmaterials.com/how-the-marine-industry-can-make-use-of-plastic-lumber/)

In one bridge application, **244** pre-compressed concrete piles were replaced with **52** plastic lumber piles. Plus, the plastic piling increased energy absorption.

(source: https://tangentmaterials.com/how-the-marine-industry-can-make-use-of-plastic-lumber/)

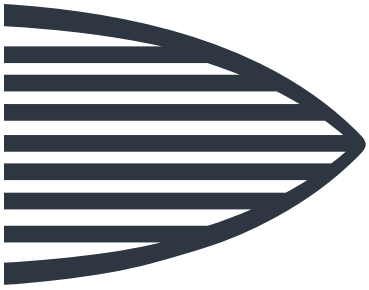


UHMW-PE replaced steel in a marine remote operated vehicle (ROV), saving **1/8th** the weight.

(source: www.curbellplastics.com/Research-Solutions/Industry-Solutions/Case-Studies/Weight-Reduction-for-ROV-(Remote-Operated-Vehicle))

Synthetic teak made from PVC fills the role of a teak deck without impacting endangered timbers.

(source: https://nuteak.com/responsible-applications-for-plastic/)



PVC deck hatch covers help to reduce heat, making it more comfortable inside the boat and preventing the interior surfaces from fading. Just hours after covers were installed, it was cool enough for the two air conditioning units to cycle off, even during a hot summer afternoon.

(source: www.curbellplastics.com/Research-Solutions/Industry-Solutions/Case-Studies/Weight-Reduction-for-ROV-(Remote-Operated-Vehicle))

MATERIAL HANDLING

Moving materials from one place to another seems like it should be simple, but to do it quickly and cost-effectively requires specialty equipment featuring performance plastics.

APPLICATIONS

- Bearings, bushings, bearing cages
- Wear pads
- Rollers
- Sheaves/pulleys
- Guides
- Cams/cam followers
- Edge guards/profiles
- Auger edge strips
- Chute liners
- Windows
- Light shields
- Safety sight guards
- Sight glasses (flow control)
- Feed/timing screws
- Star Wheels
- Venturi throat liners

ADVANTAGES MAY INCLUDE

- Low coefficient of friction
- Noise and vibration attenuation
- High flexibility for ease of installation
- Abrasion resistant
- Static dissipative and conductive grades
- Corrosion resistant
- Lightweight
- Impact resistant
- Light transmission/clarity
- Temperature resistance (hot or cold)

MATERIALS

- Acrylic (PMMA)
- Nylon (PA)
- Polycarbonate (PC)
- Polyetheretherketone (PEEK)
- Polyethylene (PE)
- Polypropylene (PP)
- Polytetrafluoroethylene (PTFE)
- Polyethyleneterephthalate (PET)
- Polyurethane (PU/PUR)
- Polyvinyl Chloride (PVC)
- Polyamide-Imide (PAI)
- Ultra-high Molecular Weight Polyethylene (UHMW-PE)

DID YOU KNOW?

Conveyor belts date back to 1795, when they were made of leather and used for very short distances. Today, the longest single conveyor belt in the world is in the phosphate mines of the Western Sahara. It measures 61 miles in length.

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MATERIAL HANDLING

SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS

UHMW weighs **⅛** as much as steel but can outlast it **3:1** in most conveyor applications, saving energy in transporting the material and the waste of replacing the steel parts. Plus, noise levels can be reduced up to **50%**

(source: www.lehighvalleyplastics.com/material-handling/)

Nylon sheaves are **¼** the weight of steel, offer load-bearing capabilities up to **4,000 psi** and compressive strength of **15,000 psi**

(source: http://redwoodplastics.com/wp-content/uploads/2021/Forestry-Sawmill-Biomass-PulpPaper-03-2021.html)

Polycarbonate is **30x** stronger than acrylic and more than **200x** stronger than glass, yet is lightweight, weighing **6x** less than glass, making it an ideal material for machine guards.

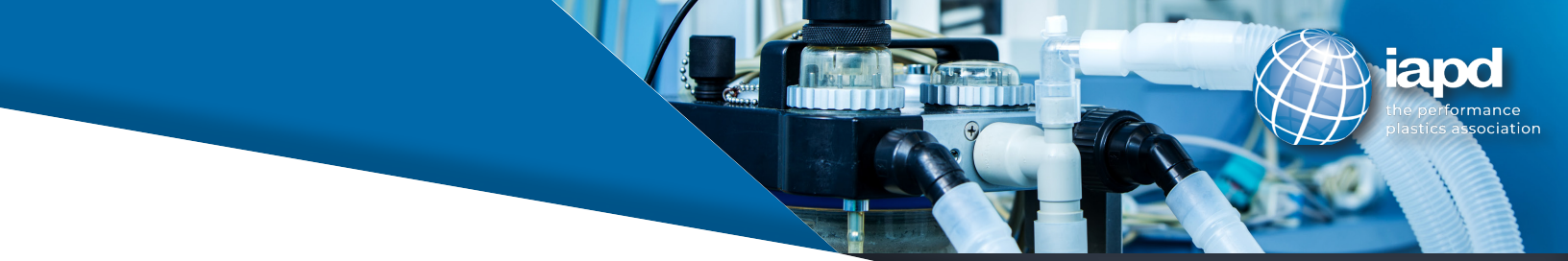
(source: www.piedmontplastics.com/blog/delivering-products-efficiently-one-package-at-a-time)

Pulleys made from performance plastics are light weight (**7-8x** lighter than steel), corrosion resistant, reduce noise levels and can extend the cable life of units up to **400%**

(source: www.lehighvalleyplastics.com/material-handling/)

In sand-slurry wear tests, performance plastics achieve a **46%** better service life than steel.

(source: www.roechling.com/us/industrial/bulk-material-handling)



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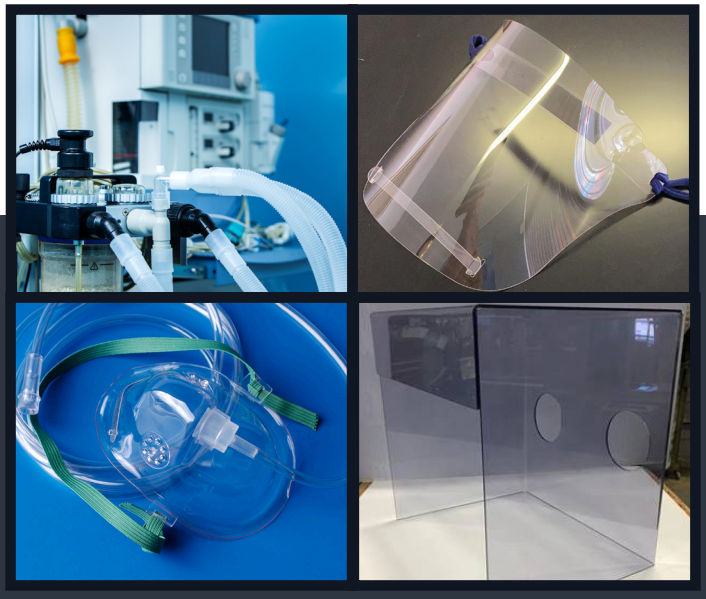
MEDICAL

Performance plastics are facilitating a new frontier of more types of outpatient treatments, less invasive procedures and longer lasting materials. Plus, anti-microbial plastics cut down on infections.

APPLICATIONS

- Surgical instrument handles/ grips
- Dental instrument handles/grips
- Orthopedic implants
- Pacemaker leads
- Endoscopic housing/eyepieces
- Sterilization trays/caddies
- X-ray and MRI parts
- Dialysis machines housings
- Respiratory units
- Pharmaceutical production/ packaging
- Fluid distribution-valve housings/ nozzles
- IV and infusion devices
- Diagnostic systems
- Feeding tubes
- Catheters



ADVANTAGES MAY INCLUDE

- Low manufacturing costs
- Low friction and wear
- Lightweight
- Resistant to high temperature, impact, chemicals
- Color coding options
- Easy to create ergonomic designs
- Maintains physical properties under thermal, chemical or electrical stress
- Good strength, toughness and hardness
- Can handle repeated sterilization
- Antimicrobial options
- Excellent wear properties
- Low-friction performance
- High purity
- Meets health regulations
- Meets precise dimensions
- Abrasion and shatter resistant
- Excellent thermal and oxidative stability

MATERIALS

- Acetal Copolymer (POM)
- Cyclic Olefin Copolymer (COC)
- Ethylene-Vinyl Acetate (EVA)
- Liquid Crystal Polymer (LCP)
- Polycarbonate (PC)
- Polyetheretherketone (PEEK)
- Polyethylene (PE)
- Polyetherimide (PEI)
- Polymethyl Pentene (PMP)
- Polyphenylene Oxide (PPO)
- Polyphenylene Sulfide (PPS)
- Polyphenylsulfone (PPSU)
- Polypropylene (PP)
- Polysulfone (PSU)
- Polyvinyl Chloride (PVC)
- PVC/Acrylic Alloy Sheet
- Silicone (SI)
- Styrene Acrylonitrile Copolymer (SAN)
- Styrene Maleic Anhydride-Polycarbonate (SMA-PC)
- Thermoplastic Elastomer (TPE)
- Thermoplastic Polyester (PBT)
- Thermoset Composite (Phenolics)
- Ultra-High Molecular Weight Polyethylene (UHMW-PE)

DID YOU KNOW?

Intravenous technology was first published in 1883 by Dr. Thomas Latta during a cholera epidemic in Britain. The standard IV use of saline solutions did not begin until 1902.

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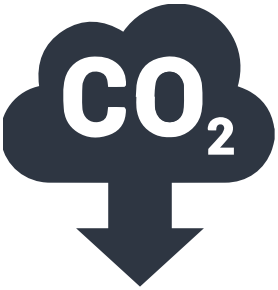
MEDICAL

SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS

An infrared thermometer made from performance plastics could reduce more than **150,000,000** plastic caps in hospital waste every year.

(source: www.henleysmed.com/tritemp-non-contact-thermometer-for-healthcare-professionals-2)

Upcycled PBT, a material used in the healthcare industry, reduces global warming impact by **29%**, has **43%** less cumulative energy demand and consumes **15%** less water compared with virgin PBT.



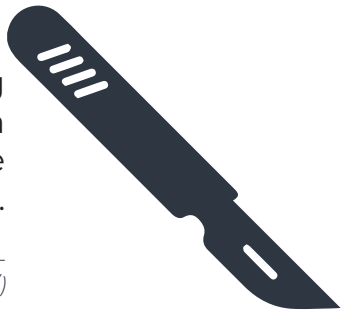
This upcycling process converts commodity plastic waste into virgin-quality engineering resin at reduced CO_2 emission levels compared with the production of virgin resin.

(source: https://www.ondrugdelivery.com/sustainable-polymers-for-healthcare-help-advance-the-circular-economy/)

A 330 ml plastic pill bottle contains ~18 grams of plastic, while a comparable glass bottle can weigh anywhere from 190-250 grams. Transporting these heavier glass containers can require up to **40%** more energy, with a corresponding increase in greenhouse gas emissions, and can increase transport costs by up to **5x** per bottle.

(source: www.hprc.org/advanced-recycling-white-paper)

Performance plastics are **1/7** the weight of some metals. Making medical instruments out of plastic keeps their weight to a minimum, enhancing the comfort level of devices and tools for the medical practitioner and minimizes fatigue during surgeries.



(source: https://www.medicalplasticsnews.com/medical-plastics-industry-insights/medical-plastics-materials-insights/10-advantages-of-using-plastic-rather-than-metal/)

Compared with metals, plastic medical instruments are the preferred sustainable option. The carbon footprint of these instruments is minimal and can help achieve net-zero relative to the average CO_2 equivalent annual emission from a hospital that uses conventional metal instruments. For instance, injection molding creates minimal scrap compared to metal. It also requires a lower heating temperature than a metal, which uses less energy.

(source: https://www.medicalplasticsnews.com/medical-plastics-industry-insights/medical-plastics-materials-insights/10-advantages-of-using-plastic-rather-than-metal/)

MINING

Performance plastics help reduce noise, prolong equipment life and protect miners. From safety equipment to truck bed liners to parts such as gears, rollers, sprockets and so on, try mining plastics for long- lasting applications.

APPLICATIONS

- Grating systems
- Wear pads/strips
- Thrust washers
- Conveyor components — gears, rollers, bushings, sheaves, sprockets
- Chemical delivery pipe systems
- Dewatering systems
- Star wheels
- Lantern rings in centrifugal mining pumps
- Vibrating bin dischargers
- Leachate systems
- Front end loader bucket liners
- Specialized precious metal recovery systems (froth flotation)
- Off-road truck beds, truck liners
- Hopper car liners
- Safety windows/windshields
- Belt scrapers, tooth locks, impact pads
- Chute liners

ADVANTAGES MAY INCLUDE

- Available in static dissipative and conductive versions
- Low coefficient of friction
- Self-lubricating
- High pressure/velocity performance
- Superior abrasion, chemical and wear resistant
- Zero to low moisture absorption
- Noise reduction
- Impact and corrosion resistant
- Heat stabilized
- Strength and toughness
- Very low coefficient of linear thermal expansion
- Weight reduction
- Reduces/eliminates arching, ratholing and erratic flow
- Flame retardant versions available
- Dimensional stability
- Resistant to high-energy radiation
- Minimizes wear on mating metal parts
- Smoother system operation

MATERIALS

- Acetal (POM)
- Acrylonitrile-Butadiene-Styrene (ABS)
- Acrylic (PMMA)
- Epoxy
- Ethylene-Chlorotrifluoroethylene (ECTFE)
- Fiber-Reinforced Polymer (FRP)
- High-Density Polyethylene (HDPE)
- Nylon/Cast Nylon (PA)
- Phenolic (Industrial Thermosets)
- Polycarbonate (PC)
- Polyetheretherketone (PEEK)
- Polyphenylene Sulfide (PPS)
- Polypropylene (PP)
- Polyurethane (PU/PUR)
- Polyvinyl Chloride (PVC)
- Polyvinylidene Fluoride (PVDF)
- Ultra-High Molecular Weight Polyethylene (UHMW-PE)

DID YOU KNOW?

Luck of the Irish' is an old mining term. During the gold and silver rushes in Western America, some of the most famous and successful miners were Irish immigrants or of Irish descent. This phenomenon gave rise to the phrase "The Luck of the Irish."

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MINING

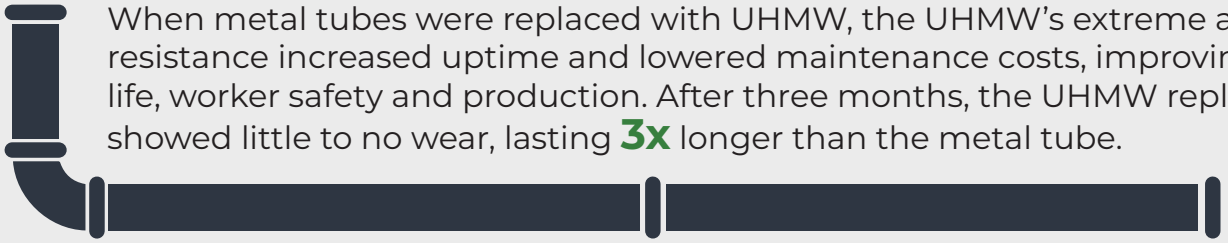
SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS

UHMW plates on the outside of blasting machines protect expensive machinery from rocks and unintended shrapnel. More than **5x** as resistant to abrasion as steel, a 1" thick slab of UHMW is able to stop a .45 caliber bullet from 25 feet away. This level of protection stops flying rocks in their tracks.

(source: https://plasticmachiningcompany.com/mining-industry-applications-plastic-wear-power-transmission-parts/)

Many coal mining and ore mining operations have switched from stainless steel linings and hoppers to those made from UHMW. Heat buildup due to friction is greatly reduced in the UHMW linings and hoppers. Many coal and ore operations report increases of **10-15x** service life by replacing metal with UHMW.

(source: https://plasticmachiningcompany.com/mining-industry-applications-plastic-wear-power-transmission-parts/)



When metal tubes were replaced with UHMW, the UHMW's extreme abrasion resistance increased uptime and lowered maintenance costs, improving part life, worker safety and production. After three months, the UHMW replacement showed little to no wear, lasting **3x** longer than the metal tube.

(source: https://plasticmachiningcompany.com/mining-industry-applications-plastic-wear-power-transmission-parts/)

In addition to the Life Cycle Capital Cost advantage of HDPE pipe, additional savings accrue to the owner because the "allowable water leakage" is **0** rather than typical the leakage rates of **10-20%** for PVC and Ductile Iron.

(source: https://plasticpipe.org/MunicipalIndustrial/Municipal_Industrial/Applications/Mining-Applications---HDPE.aspx)

When coal mines close, a final cover system made from performance plastics can be installed more than **50%** faster than traditional closure systems. Plus, it eliminates the need for large quantities of soil and related equipment usage, dramatically improving site safety and decreasing its carbon footprint by almost **80%**.

(source: https://agruamerica.com/application/ccr/)

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MRO MANUFACTURING

Performance plastics provide numerous advantages for any manufacturing operation. They're lightweight, hold up well under extreme conditions and are an excellent cost-effective alternative to metal.

APPLICATIONS

- Bushings and bearings
- Electrical insulators
- Gears, manifolds, pulleys, cams
- Rollers
- Patterns
- Parts carriers
- Dunnage
- Sheaves
- Slide pads
- Sprockets
- Valve components
- Corner tracks, rails, bumpers
- Wheels
- Housings
- Guards and safety shields
- Structural parts
- Electrical insulators
- Chain guides, machine guards, wear strips
- Housings
- Seals and gaskets
- Star wheels
- Valve components
- Windows
- Shaft collars

ADVANTAGES MAY INCLUDE

- Lightweight (easier to handle, store and less Reliable, durable, long-lasting
- Easy to fabricate
- May eliminate the need for additional lubrication
- Excellent electrical properties
- Lightweight
- Quiet
- Minimizes wear on mating metal parts
- High strength-to-weight ratio
- Excellent surface appearance
- Impact and abrasion resistant
- Machinability and weldability
- Chemical and corrosion resistant
- Cost effective
- Excellent bearing and wear

MATERIALS

- Acetal (POM)
- Acetate (AC)
- Acrylonitrile-Butadiene-Styrene (ABS)
- Acrylic (PMMA)
- Chlorinated Polyvinyl Chloride (CPVC)
- Glycol Modified Polyester Terephthalate (PETG)
- High-Density Polyethylene (HDPE)
- Nylon/Cast Nylon (PA)
- Phenolics (Industrial Thermosets)
- Plastic Lumber
- Poly-Imide (PI)
- Polyamide-Imide (PAI)
- Polybutylene Terephthalate (PBT)
- Polycarbonate (PC)
- Polyetheretherketone (PEEK)
- Polyester films
- Polyethylene Terephthalate (PET/PETE)
- Polyphenylene Sulfide (PPS)
- Polypropylene (PP)
- Polysulfone (PSU)
- Polytetrafluoroethylene (PTFE)
- Polyurethane (PU/PUR)
- Polyvinyl Chloride (PVC)
- Polyvinylidene Fluoride (PVDF)
- Silicone (SI)
- Ultra-High Molecular Weight Polyethylene (UHMW-PE)

DID YOU KNOW?

The manufacturing sector is a major part of the economy as it accounts for nearly 16% of the global GDP in 2018.

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MRO MANUFACTURING

SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS

MRO can make up anywhere from **5-30%** of a manufacturing company's spending. Cost savings are possible with longer-lasting performance plastics parts, plus waste is reduced.

(source: https://verusen.com/mro-optimization-best-practices-for-2022/)

Nylon sheaves are **¼** the weight of steel, offer load bearing capabilities up to **4,000 psi** and compressive strength of **15,000 psi**

(source: http://redwoodplastics.com/wp-content/uploads/2021/Forestry-Sawmill-Biomass-PulpPaper-03-2021.html)

Nylon sheaves can increase the life of steel cables by up to **600%**

(source: www.redwoodplastics.com/industry-solutions/oil-gas/)

With a low coefficient of friction, superior abrasion and corrosion resistance, UHMW has been proven to outlast mild and hardened steel by as much as **10 to 1**

(source: http://redwoodplastics.com/wp-content/uploads/2021/Forestry-Sawmill-Biomass-PulpPaper-03-2021.html)

PVC windows last up to **40 years** and are **100% recyclable**

(source: www.shiniusa.com/2018/01/29/recycled-plastics-construction/)

Polycarbonate is **30x** stronger than acrylic and more than **200x** stronger than glass, for greater longevity in safety shield applications.

(source: www.piedmontplastics.com/markets/food-processing-and-handling)

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OIL & GAS

Performance plastics are playing a key role in the energy boom, making it easier to reach previously untapped sources of oil and gas to fuel the economy.

APPLICATIONS

- Piston, chevron and gland seals
- Anti-extrusion rings and back-up rings
- Valve seats
- Packings
- Bushings, bearings
- Lantern rings
- Frac balls
- Labyrinth seals
- Down-hole electrical insulators
- Gaskets
- Lifting systems components (sheaves, rollers, guides)
- Shrouds
- Sight glasses
- Pipe and pipe support systems (saddles, carrier rings) grating/stairs

ADVANTAGES MAY INCLUDE

- Reduced weight and lower cost than traditional materials (specialty metals)
- Better sealing performance
- Greater design flexibility (most engineering plastics are readily modified for specific applications)
- Handles harsh environments (from downhole heat to Arctic conditions to subsea systems)
- Corrosion resistant
- Improved efficiencies (better sealing properties, lower coefficient of friction)
- Easier to machine, ship and install
- Reduce/eliminate lubrication dependency
- Excellent electrical insulation properties
- Static dissipative and conductive grades available
- Less wear on mating parts

MATERIALS

- Acrylonitrile Butadiene Styrene (ABS)
- Chlorinated Polyvinyl Chloride (CPVC)
- Nylon (PA)
- Other Fluoropolymer Compounds
- Polyetheretherketone (PEEK)
- Polyethylene (PE)
- Polytetrafluoroethylene (PTFE)
- Polyphenylene Sulfide (PPS)
- PolyAmide-Imide (PAI)
- Polyimide (PI)
- Thermoset Composites (Phenolics)

DID YOU KNOW?

Even small percentage efficiencies gained by replacing metallic labyrinth turbocompressor seals with abradable or wear resistant polymeric seals can result in hundreds of thousands of dollars in increased production.

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OIL & GAS

SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS

Compared to steel, performance plastics do not require sacrificial cathodic protection and offer a weight savings of up to **70%**, leading to a reduction on the loads of the secondary support structures and an increase in operational efficiency.

(source: www.roechling.com/us/industrial/oil-and-gas/topside)

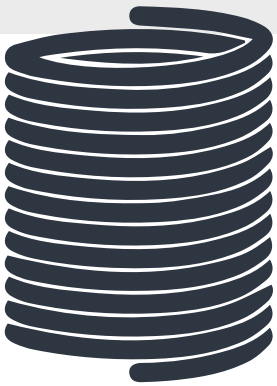
Polycarbonate is **30x** stronger than acrylic and more than **200x** stronger than glass. It can be used in applications such as safety partitions and heavy equipment glazing.

(source: www.piedmontplastics.com/markets/oil-and-gas)

Outrigger pads made with performance plastics are **⅐** the weight of steel and can withstand loads up to **3,000 psi** and more than **1,000,000** of compressive load.

(source: www.redwoodplastics.com/materials/outrigger-pads/)

Nylon sheaves can increase the life of steel cables by up to **600%**, resulting in less waste.



(source: www.redwoodplastics.com/industry-solutions/oil-gas/)

Nylon sheaves are **⅐** the weight of metal sheaves, resulting in less energy required for operations.

(source: www.roechling.com/us/industrial/oil-and-gas/topside)

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PHARMACEUTICAL

Performance plastics are booming in the pharmaceutical industry because of their durability, ability to be sterilized, easy machinability to exacting specifications and cost effectiveness.

APPLICATIONS

- Tanks (water, chemical, fuel)
- Pharmaceutical pill and tablet production
- Intravenous and infusion devices, such as insulin pens and inhalers
- Blister packaging
- Pharmaceutical pouches for dose packaging of powder and topical medicines
- Strip packs for sample-size oral drug applications
- Medication tubes
- Parenteral packages
- Pre-fillable dose-measured syringes
- Tamper-evident and childproof closures
- Droppers
- Measuring caps and spoons
- Bottles for: opthalmic use, syrup, tablets, drops
- Drinkable single dose systems
- Vials
- Ampules
- Syringes
- Intravenous containers

ADVANTAGES MAY INCLUDE

- Can be sanitized using hot or cold water combined with detergents and other harsh chemical cleaners
- Easily fit into self-lubricating devices
- Lightweight
- Complies with North American and European regulations
- Cost effective
- Nonflammable
- Delivers critical and emergency medication quickly
- Antimicrobial options prevent infections
- Versatile; easily machined to precise specifications
- Materials meet highest USP or FDA standards
- Dimensional precision
- Chemical stability
- Mechanical and temperature resistant
- Machines well for design functionality and ergonomics

MATERIALS

- Acetal (POM)
- Acetal (POM)
- Acrylic (PMMA)
- Acrylonitrile-Butadiene-Styrene (ABS)
- Ethylene-Chlorotrifluoroethylene (ECTFE)
- High-Density Polyethylene (HDPE)
- Nylon/Cast Nylon (PA)
- Polycarbonate (PC)
- Polyester Terephthalate Glycol Modified (PETG)
- Polyetherimide (PEI)
- Polyethersulfone (PES)
- Polyethylene (PE)
- Thermoplastic Elastomer (TPE)
- Thermoplastic Polyester (PBT)
- Ultra-High Molecular Weight Polyethylene (UHMW-PE)
- Polyethylene Terephthalate (PET)
- Polyphenylene Sulfide (PPS)
- Polypropylene (PP)
- Polystyrene (PS)
- Polyvinyl Chloride (PVC)
- Polyvinylidene Fluoride (PVDF)

DID YOU KNOW?

Plastics are the leading materials used in pharmaceutical packaging based on the breadth of applications for which they are suitable, their cost effectiveness and their favorable barrier and aesthetic properties.

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PHARMACEUTICAL

SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS

A 330 ml plastic pill bottle contains ~18 grams of plastic, while a comparable glass bottle can weigh 190-250 grams. Transporting the heavier glass containers can require up to **40%** more energy, with a corresponding increase in greenhouse gas emissions, and can increase transport costs by up to **5x** per bottle.

(source: www.hprc.org/advanced-recycling-white-paper)

Switching to a label with 10µm less thickness is unnoticeable when it comes to performance and appearance, but adds up to substantial environmental benefits. Avery Dennison compared their PP50 (50µm) and PP40 (40µm) labels — used for prefilled syringes, vials, nasal sprays, pill bottles and other general applications — and found that the thinner label used **11%** less fossil material, **6%** less energy, **4%** less water and produced **7%** less greenhouse gas. Thinner label materials also allow for longer printer rolls, which means less changeover and downtime on the production line.

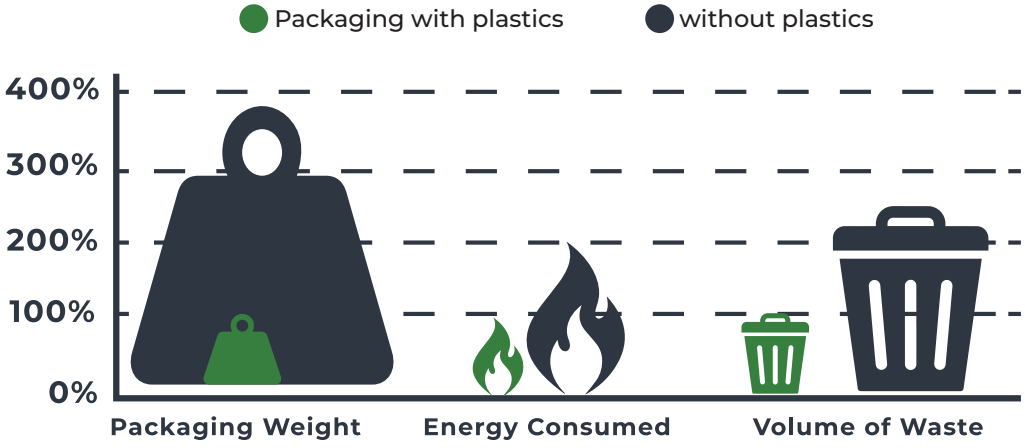
(source: https://label.averydennison.com/eu/en/home/news-and-insights/reduce-healthcare-waste-with-sustainable-packaging.html)

Innovators have manufactured plastic using antimicrobial materials that reduce bacteria by up to **99.99%**.

(source: www.plastivision.org/blog/medical-grade-plastic-and-its-incredible-advantages-to-the-industry/)

The ratio of plastic weight involved in packaging to that of the product is usually ~10%.

(source: https://bioprocessintl.com/manufacturing/single-use/the-green-imperative-part-two-engineering-for-the-new-plastics-economy-and-sustainability-in-single-use-technologies/)



(source: https://www.bpf.co.uk/sustainability/plastics_and_sustainability.aspx)

RECREATIONAL

From swimming pools to roller coasters to basketball backboards to playground equipment, if you're having fun, chances are performance plastics are along for the ride. Relax and enjoy the durability of plastics!

APPLICATIONS

- Swimming Pools — water treatment, pool enclosures, diving boards, piping
- Snowmobiles — skis, slide suspensions, sprockets, fuel lines, windshields, bumpers, bearings and bushings
- Amusement park rides — signage, housings, wheels, bumpers/rub rails, benches, piping, canopies
- Bowling alleys — pin guides, kick plates, ball returns, rollers
- Reproductions of jukeboxes — windows, housings
- Hockey shielding and dasher systems
- Playground equipment
- Parks — picnic tables, basketball backboards
- Piping
- Waterslides
- Signage
- Skylights

ADVANTAGES MAY INCLUDE

- Lightweight (easier to handle, store and less Weather, UV, fire and chemical resistant
- Sound deadening/attenuation
- Impact and wear resistance
- Provides variety of rolling resistances, load bearing capacities and hysteresis characteristics (for roller coaster designs)
- Shatterproof
- Easy to fabricate and thermoform
- Lower incidents of breakage means less need to maintain replacement stock
- Available in many colors
- Allows maximum daylight into interior spaces
- Can withstand extreme temperatures
- Thermal insulation
- Reduces heat build-up in hot climates
- Less breakage means safer designs

MATERIALS

- Acrylonitrile-Butadiene-Styrene (ABS)
- Acetal (POM)
- Acrylic (PMMA)
- High-Density Polyethylene (HDPE)
- Nylon (PA)
- Polycarbonate (PC)
- Polyethylene (PE)
- Polypropylene (PP)
- Polytetrafluoroethylene (PTFE)
- Polyurethane (PU/PUR)
- Polyvinyl Chloride (PVC)
- PVC/Acrylic Alloy
- Ultra-High Molecular Weight Polyethylene
- (UHMW-PE)

DID YOU KNOW?

The U.S. theme park Six Flags Great Adventure had the highest roller coaster worldwide in 2020; its attraction Kingda Ka was 139 meters high.

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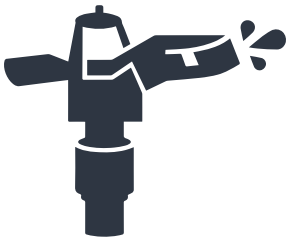
RECREATIONAL

SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS

The grass-like blades in synthetic turf are made from polymers, with recycled tire rubber used as infill and/or as cushioning. Synthetic turf resembles grass, conserves water compared to natural grass and lasts for **8-10 years**

(source: www.stopwaste.org/sites/default/files/SW-FactSheet-RecycledContent-Parks-and-Rec-Products-20170502.pdf)

One synthetic lawn sporting field can reduce water consumption by more than **500,000 gallons** annually, conserving water and reducing water bills.



(source: www.stopwaste.org/sites/default/files/SW-FactSheet-RecycledContent-Parks-and-Rec-Products-20170502.pdf)

A typical set of playground equipment made with recovered-content plastic lumber can contain plastic recovered from between **31,500-63,000** milk and water jugs.

(source: www.epa.gov/smm/comprehensive-procurement-guidelines-park-and-recreation-products)

It takes approximately **240** gallon-size milk jugs to create a recycled plastic armchair.

(source: www.aaastateofplay.com/how-does-recycled-plastic-park-furniture-benefit-the-environment/)

PPDI urethane doubled the wheel life of the Desperado roller coaster at Buffalo Bill's Resort & Casino in Primadonna, NV, USA and saves about **$20,000** a season on wheel costs, not including the labor for wheel changes, plus reduces the number of wheels being thrown away by **50%**.

(source: www.plasticsnews.com/article/19960527/NEWS/305279963/hylene-doubles-roller-coaster-wheel-life)

The boardwalks surrounding the Old Faithful Geyser in Yellowstone National Park are made from recycled plastic the equivalent of **3,000,000** plastic milk jugs. These walkways not only have a lower environmental footprint than alternatives, but also protect visitors and natural spaces while increasing accessibility for all. National Park signs, which are durable and resistant to extreme weather, are made of HDPE which ensure that guests remain safe and trails are clearly defined.

(source: https://thisisplastics.com/environment/plastics-make-national-parks-even-more-environmentally-friendly/)

SECURITY

Polymers, both transparent and opaque, are used in the construction of armor to protect people from physical assault, bullets and bomb blast attacks. Performance plastics keep people safe.

APPLICATIONS

- Bank windows
- Convenience store/gas station cashier glazing
- Courtroom/judge's bench shields
- Embassy windows
- Military/police face shields
- Military vehicle windows
- Prison/detention center glazing
- Riot shields
- VIP vehicle windows
- Weather rated windows (flying debris resistant)
- Security entryways
- Armored car construction

ADVANTAGES MAY INCLUDE

- Lightweight (easier to handle, store and less Optical transparency
- Impact resistance at high strain rates
- Lightweight for easy installation
- Easy to fabricate (drill holes, polish, etc.)
- Easy to laminate with multiple materials
- Ease of application and replacement

MATERIALS

- Acrylic (PMMA)
- Ionomer
- KEVLAR® aramid fiber reinforced thermoplastics
- Polycarbonate (PC)
- Reinforced thermoset laminate shielding

DID YOU KNOW?

The window laminate that protects the U.S. President's limousine can withstand a 50-caliber bullet. New building codes require security-type laminated windows in areas prone to tornadoes and hurricanes. The plastic laminate structure works by converting kinetic energy into heat energy, allowing it to bend without shattering.

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SECURITY

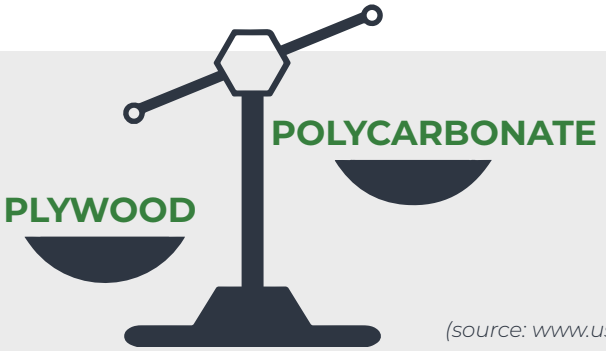
SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS

More than **3,000** police officers' lives have been saved over the past 30 years, thanks in part to the performance plastics in their protective vests.

(source: https://www.fas.org/sgp/crs/misc/R43544.pdf)

Polycarbonate is **250x** more impact resistant than glass, making it an ideal material for hurricane panels.

(source: www.polymershapes.com/polycarbonate-hurricane-panels-2/)



Multi-wall clear polycarbonate is less than **25%** the weight of plywood, lowering the amount of fuel needed to transport the material.

(source: www.usplastic.com/catalog/item.aspx?itemid=24920)

Acrylic is **17x** stronger than regular silica glass, making it an ideal material for bulletproof glazing, plus it is resistant to shattering.

(source: https://plasticmachiningcompany.com/mining-industry-applications-plastic-wear-power-transmission-parts/)

Polycarbonate is **10x** more impact resistant than regular plastics and an excellent choice for safety goggles. Whereas glass and regular plastics are likely to crack if hit with an airborne object, polycarbonate is softer and therefore can absorb energy. In addition, polycarbonate blocks **100%** of UV rays without the need for an additional coating, protecting eyesight from damage caused by these rays.

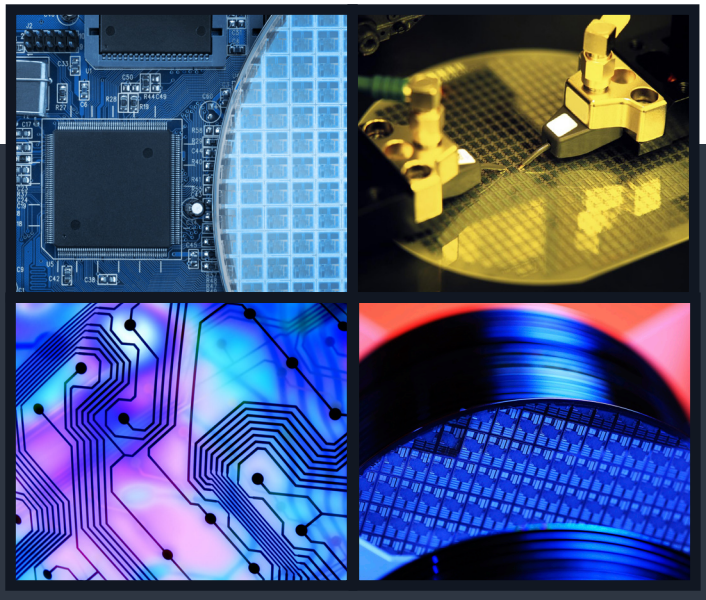
(source: https://eaglesafety.com/what-should-my-safety-glasses-be-made-of/)

SEMICONDUCTOR

Semiconductor manufacturing involves harsh chemicals, exacting high purity requirements and resistance to electrical shock, as well as cost effectiveness.

APPLICATIONS

- Tanks (water, chemical, fuel)
- Semiconductor device test sockets
- Circuit boards
- High temperature components
- Integrated circuit chip carriers
- High-purity piping systems
- Semiconductor trays and boxes
- Electrical insulators
- Chemical tanks
- Piping components such as valves, fittings, pipe and tubing, filtration elements
- Wafer handling parts
- Wet benches and work stations
- Microelectronics
- Flexible tubing
- Components used to control static electricity
- Ultrapure water systems
- Vacuum wand tips
- Waste transfer lines



ADVANTAGES MAY INCLUDE

- Lightweight
- Abrasion resistant in polishing slurries
- Resistant to corrosive acids
- Inert to common process chemicals
- Low outgassing characteristics
- Minimal contamination to flow
- Perform well in extreme heat; nonflammable
- Static dissipative properties
- Sophisticated joining equipment minimizes or eliminates possible joint contamination
- Cost effective
- Electrical insulating properties
- Low particle generation in bearing and wear applications

MATERIALS

- Acetal (POM)
- Chlorinated Polyvinyl Chloride (CPVC)
- Ethylene-Chlorotrifluoroethylene (ECTFE)
- Ethylene-Tetrafluoroethylene (ETFE)
- Fluorinated Ethylene Propylene (FEP)
- Perfluoroalkoxy (PFA)
- Polyamide-Imide (PAI)
- Polycarbonate (PC)
- Polyetheretherketone (PEEK)
- Polyetherimide (PEI)
- Polyethylene Terephthalate (PET)
- Polyphenylene Ether (PPE)
- Polyphenylene Sulfide (PPS)
- Polypropylene (PP)
- Polysulfone (PSU)
- Polytetrefluoroethylene (PTFE)
- Polyvinyl Chloride (PVC)
- Polyvinylidene Fluoride (PVDF)
- Polyimide (PI)

DID YOU KNOW?

Semiconductors are made in special manufacturing facilities called fabs. Within these fabs are cleanrooms, which are enclosed areas with strict controls for airborne contamination, humidity, and temperature.

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SEMICONDUCTOR

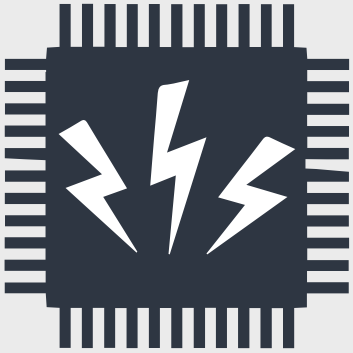
SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS

Single-use cleanroom materials such as garments, hairnets, laboratory gloves and boot covers are being recycled into plastic benches and chairs, bulk plastics and much more. More than **99%** of manufacturing waste has been diverted from landfills through these recycling initiatives.

(source: www.terrauniversal.com/blog/cleanrooms-making-world-better-place/)

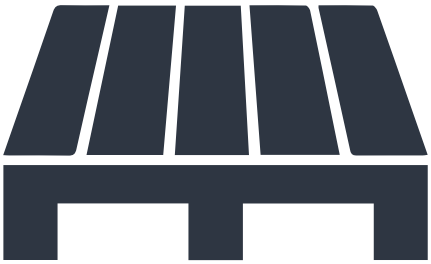
High purity **100%** homopolymer PVDF is non-leaching and does not support growth of biological impurities, making it suitable for high and ultrapure applications.

(source: www.processengineer.com/material-selection-for-chemical-process-equipment-plastics/)



Electrostatic discharge (ESD) costs the semiconductor industry more than US$4 billion in lost profits each year with around 25% of all components failures attributed to ESD. Performance plastics can be static dissipative and help to reduce the number of ESD events, saving the industry billions.

(source: www.aiplastics.com/blog/semiconductor-and-electrical-applications)



A durable plastic pallet is more hygienic than a wood pallet and can be sanitized and kept in nearly microbe-free storage during transportation.

(source: https://igps.net/resources/cleanroom-pallets-choosing-a-hygienic-plastic-pallet-for-cleanroom-applications/)

SIGN & VISUAL

Looking for a durable, weather-resistant material to produce eye-catching graphics, advertising or P-O-P marketing? All signs point to performance plastics.

APPLICATIONS

- Outdoor signage
- Backlit/electrical signs (LEDs)
- Wall mounted signs
- Channel letters
- Touch/interactive signs
- Banners
- Sign boards (menu boards)
- Advertising (indoor and outdoor)
- Bus (mobile and shelter) signs
- Video walls
- Countertop signs
- Freestanding signs
- Indoor (retail) P-O-P signage
- Digital signage
- Safety and emergency signage
- DOT and construction signage
- Directional (way finder) signage
- Real estate signage
- Window graphics
- ADA signage

ADVANTAGES MAY INCLUDE

- Optical clarity
- Lightweight
- UV resistance
- Impact, corrosion and fire resistant (toughness)
- Easy to fabricate
- Fast drying times
- Fast cycle times
- Printable (digital and screen)
- Design flexibility
- High heat deflecting temperature
- Better thermoforming definition
- No pre-drying required (with Copolyesters and PETG)
- High light transmission
- Wide variety of colors and finishes
- Color stability
- Excellent weatherability
- FDA compliance
- Heat resistant
- Chemical resistant
- Recyclable
- Materials do not contain Bisphenol-A (BPA)

MATERIALS

- Acrylic (PMMA)
- Acrylonitrile-Butadiene-Styrene (ABS)
- Cellulosics (CAB)
- Copolyester (COP)
- Fabrics/textiles
- Polycarbonate (PC)
- Polyester Terephthalate Glycol Modified (PETG Copolymer)
- Polyester film
- Polyethylene (PE)
- Polypropylene (PP)
- Polystyrene (high impact screen and digital grade) (PS)
- Polyurethane (PU/PUR)
- Polyvinyl Chloride (PVC)
- PVC/Acrylic Alloy
- Vinyl

DID YOU KNOW?

Plastics can be greener than wood! For example, the environmental impact of manufacturing a sign from performance plastics that lasts for 10 years (or more) is about half of one made from wood that only lasts five years.

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SIGNAGE & VISUAL

SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS

HDPE is commonly used to make outdoor signage. More than **115 million** milk jugs are recycled each year to make recycled HDPE. Approximately **8-10** recycled milk jugs make up a pound of HDPE.

(source: https://areteindustries.us/hdpe-plastics/)

The environmental impact of manufacturing a performance plastics sign that lasts for 10 years is about **50%** of one made from other materials that only lasts for 5 years. Longer-lasting signs have smaller carbon footprints because they require less maintenance.

(source: www.metrosignandawning.com/sign-materials-matter-when-plastic-is-greener-than-wood-and-other-environmental-impact-issues/)

Developments in LED technology have made them ubiquitous for new and some retrofitted signs. The energy savings can be as much as **80%**.

(source: https://signsofthetimes.com/sustainable-sign-products-examining-manufacturers-eco-friendly-equipment-and-supplies/)

LEDs in illuminated signs last **8-10x** longer than older fluorescent lights.

(source: www.metrosignandawning.com/sign-materials-matter-when-plastic-is-greener-than-wood-and-other-environmental-impact-issues/)

Low-voltage RGB LED signage lighting can provide color-changing accents with the benefit of a white or warm-white light source. Additionally, LED signs are powered by 12 volts DC while neon, for comparison, is powered by 4,000-to-15,000-volt AC. By retrofitting old, non-energy efficient fluorescent bulbs with high-end LEDs, one company saved **10%** a month in energy costs with a return on investment of fewer than two years.

(source: www.creativesigndesigns.com/blog/sustainability-practices-for-signage/)

TRANSPORTATION

Trains, buses, trucks, boats and RVs are lighter weight, more durable, safer and more comfortable thanks to performance plastics. In both aesthetic and structural/bearing applications, plastics help you travel further for less money.

APPLICATIONS

- Marine — seating, switch board panels, relay bases, bearings, bushings, porthole windows, cabinetry, seals, trays, decking, bimini surrounds, cutting boards, anchor shrouds, fuel/ fluid handling tubing
- Mass transit (rail car and bus) — bearings, pedestal liners, coupler carrier wear plates, brake bean guides, center bowl liners, luggage compartment components, folding trays, bus windows, wall panels, mirrors, driver security glazing, air conditioning housings, lighting covers, electrical wear shoes
- RV — windshields, interior components, wear pads, lighting covers, body panels, hinge pins
- Trucks — dump truck liners, flooring, wear pads, step ups, light housings, covers, fan shrouds, snow plows, mud flaps, fifth wheel bearing plates

ADVANTAGES MAY INCLUDE

- Lightweight, resulting in better fuel efficiency
- Impact, weather, chemical, corrosion and fire resistant
- Easy to fabricate
- Reduced maintenance and downtime
- Sound dampening
- Low friction
- Design flexibility, offered in a variety of colors and decorative caps
- Easily manipulated into complex fabricated or thermoformed parts

MATERIALS

- Acetal (POM)
- Acrylic (PMMA)
- Acrylonitrile-Butadiene-Styrene (ABS)
- Epoxy
- High-Density Polyethylene (HDPE)
- Liquid Crystal Polymers (LCP)
- Nylon/Cast Nylon (PA)
- Phenolics (Industrial Thermosets)
- Polycarbonate (PC)
- Polyetheretherketone (PEEK)
- Polyetherimide (PEI)
- Polyethylene (PE)
- Polyethylene Terephthalate (PET)
- Polytetrafluoroethylene (PTFE)
- Polyvinyl Chloride (PVC)
- PVC/Acrylic Alloy
- Silicone (SI)
- Styrene Maleic Anhydride-Polycarbonate (SMA-PC)
- Thermoplastic Elastomer (TPE)
- Thermoplastic Polyesters
- Ultra-High Molecular Weight Polyethylene (UHMW-PE)

DID YOU KNOW?

Polycarbonate and acrylic glazing weighs half that of glass of the same thickness and can offer up to 30 times the impact strength. Plastic composite panels in Swiss trains has led to a 25 percent reduction in weight, for significant energy savings.

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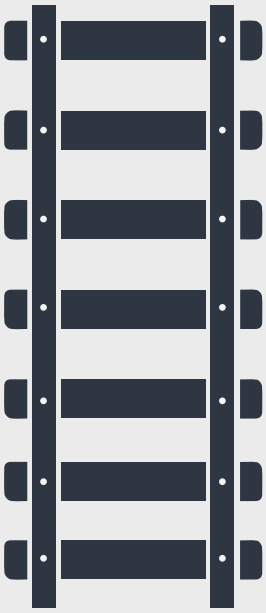
TRANSPORTATION

SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS



Approximately **21,000,000** wood railroad ties are removed from service each year in the United States. Of those, **4,000,000** end up in landfills each year. Most have been treated with creosote, which can be harmful to a person's dermal and hepatic systems and might be a human carcinogen.

(source: https://evertrak.com/essential-benefits-of-100-reinforced-recycled-plastic-ties-for-railways/)

Railroad ties made of 100% reinforced recycled plastic are not only longer lasting than their wood counterparts, but they're also as strong as a hardwood. In fact, their lifespan can be **5x** longer, serving in heavy haul track for **50+** years. Unlike wood ties, they're resistant to rotting and insect infestation. Also, because of their durability, resilience and stability, they're especially beneficial for hard-to-access and maintain areas such as bridges and tunnels.

(source: https://evertrak.com/essential-benefits-of-100-reinforced-recycled-plastic-ties-for-railways/)

The use of plastic composite panels in Swiss trains has led to a **25%** reduction in weight and consequently provided significant energy savings.

(source: https://www.bpf.co.uk/sustainability/Plastics_and_Sustainability.aspx)

A carbon footprint analysis found that using recycled plastics with recycled concrete and recycled glass saved up to **52,211 kg** CO_2 for 1 kilometer of railway track ballast.

(source: https://plasticmachiningcompany.com/mining-industry-applications-plastic-wear-power-transmission-parts/)

Replacing steel and aluminum components on public transit buses with thermoplastics and thermoplastic composite materials typically results in a **55%** weight savings.

(source: www.productiveplastics.com/thermoplastics-transit-interiors-weighing-advantages/)

Reducing vehicle weight leads to decreased energy consumption, less wear on brakes and tires and lower emissions. For example, cutting vehicle weight by 110 pounds reduces **5 grams** of carbon dioxide emissions per kilometer and increases fuel economy by **2%**.

(source: www.productiveplastics.com/thermoplastics-transit-interiors-weighing-advantages/)

Engineers at the University of Missouri are collaborating with Dow and the Missouri Department of Transportation to develop and test asphalt pavement mixtures that incorporate plastic waste. The pavement should last **10-15 years** and recycled materials such as plastic and tire rubber can extend that period by boosting strength and toughness.

(source: www.plasticstoday.com/sustainable-practices/adding-plastic-waste-asphalt-reaps-environmental-benefits)

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the performance plastics association

WATER/WASTEWATER

Performance plastics have been instrumental in reclaiming wastewater into safe water for more than seven decades. Plastics are also being put to work anywhere there's a need for durable, long-lasting, maintenance-free water transport systems.

APPLICATIONS

- Potable water systems (valve and pump components)
- Irrigation systems (bearings, nozzles, pivot bushings)
- Aquaculture
- Specialized chemical delivery systems
- Reclamation process piping
- Sprinkler/water aeration systems
- Hot and cold water distribution systems
- Plumbing pipes and fittings
- Double contained piping systems
- Water and sewage treatment — paddles, weirs, wear shoes, sprockets, chain guides
- Gravity and force main industrial and municipal sewer systems
- Ultra-pure water systems
- Submerged marine installations
- Ocean thermal energy conversion projects, designed to produce energy and air condition buildings
- Desalinization
- Grating and stair systems

ADVANTAGES MAY INCLUDE

- Lightweight
- Impact resistant
- Weather resistant
- Chemical and corrosion resistant
- Easy to fabricate
- Excellent weatherability
- Quieter than metal pipes (no "water hammer")
- Easy and safer to install
- Low maintenance
- Easy to weld, install and operate
- Excellent flexibility and bending radius (which eliminates the need for custom fittings)
- Surge-resistant
- Provides superior protection for public health when used in water treatment applications
- Fabrication can be done on-site with simple hand tools; no torches or heavy equipment needed
- Energy savings with dynamic systems (a result of plastics, lighter weight and lower specific gravity)

MATERIALS

- Acetal (POM)
- Acrylonitrile-Butadiene-Styrene (ABS)
- Cast Nylon (PA)
- Chlorinated Polyvinyl Chloride (CPVC)
- Ethylene-Chlorotrifluoroethylene (ECTFE)
- Ethylene-Vinyl Acetate (EVA)
- High-Density Polyethylene (HDPE)
- Low-Density Polyethylene (LDPE)
- Polymethyl Pentene (PMP)
- Polypropylene (PP)
- Polyvinyl Chloride (PVC)
- PVC/Acrylic Alloy
- Polyvinylidene Fluoride (PVDF)
- Thermoplastic Elastomer (TPE)
- Ultra-High Molecular Weight Polyethylene (UHMW-PE)

DID YOU KNOW?

On average, the water footprint of an American is 32,968 glasses a day, or 752,097 gallons per year. Of that amount, 96 percent is used to grow food, make clothing and generate energy.

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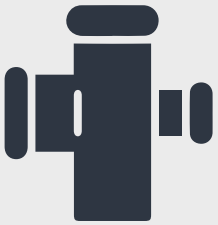
WATER/WASTEWATER

SUSTAINABILITY ADVANTAGES OF PERFORMANCE PLASTICS



PVC pipe manufacturing is extremely efficient, with virtually 100% of the PVC compound being used. It takes **4x** less energy to make PVC pipe than concrete pipe, and **50%** less than required to make iron pipe.

(source: https://www.uni-bell.org/About-Us/The-Environment)

There are no smokestacks at PVC pipe facilities and the product is **100%** recyclable, making its environmental footprint far smaller than competing piping materials. Contrast this with the cement industry – the 3rd-largest emitter of greenhouse gases in the world.

(source: https://www.uni-bell.org/About-Us/The-Environment)

PVC pipe's ultra-smooth surface reduces pumping costs, and its leak-free joints eliminate water loss – which can be up to **40%** in corrosion-prone piping networks. The American Society of Civil Engineers estimates that **2.6 trillion** gallons of potable water are lost every year through leaking pipes, or **17%** percent of all water pumped in the United States.

(source: https://www.uni-bell.org/About-Us/The-Environment)

A study by the American Water Works Association Research Foundation recently put the life expectancy of PVC pipe at more than **110 years**.

(source: https://www.uni-bell.org/About-Us/The-Environment)

Recycled HDPE pipe emits **52%** less greenhouse gas emissions than concrete and steel pipe.

(source: https://sustainability.ads-pipe.com/environmental-stewardship/environmental-benefits)

In addition to the Life Cycle Capital Cost advantage of HDPE pipe, additional savings accrue because the allowable water leakage is **0** rather than typical the leakage rates of **10-20%** for ductile iron.

(source: https://plasticpipe.org/MunicipalIndustrial/Municipal_Industrial/Applications/Mining-Applications---HDPE.aspx)

Most states allow a maximum load of 80,000 pounds when trucks have from four to seven axles. The largest single delivery for reinforced concrete pipe (RCP) would be restricted to just 64 ft of pipe. The same truck could deliver **320 ft** of corrugated HDPE pipe. If 640 linear ft of pipe was needed for a project, it would take just two trips to deliver all the needed plastic pipe versus 10 trips for RCP.

Source: https://www.plasticpipe.org/Drainage/Drainage/Sustainability.aspx)