# Amodel® PPA

## Polyphthalamide

SOLVAY

Progress beyond

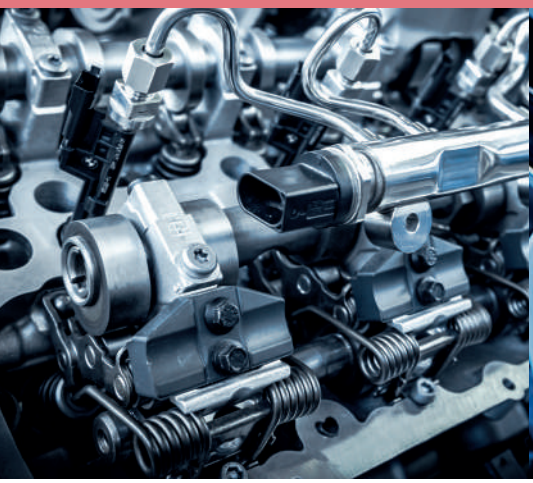
SPECIALTY
POLYMERS

# Designed to Thrive Where Only the Strong Survive

Amodel® PPA is remarkably stable at high temperatures and retains its excellent mechanical and electrical properties in high humidity and chemically aggressive environments.

Amodel® PPA delivers the performance you need when standard nylons are not enough:

- Higher strength and stiffness at elevated temperatures
- Better retention of properties in humid environments
- Greater resistance to a broader range of chemicals



## Designed for Success

Design engineers and processors in a variety of industries specify Amodel® PPA to meet the demanding requirements of critical components in tough environments.

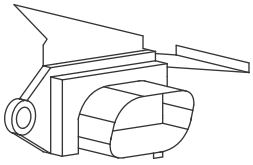
### Automotive and Transportation

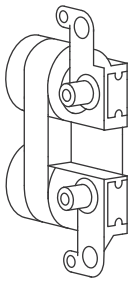
Components found under the hood of a vehicle must withstand a punishing environment that may include high temperatures, humidity and exposure to aggressive chemicals. Typical applications include control system enclosures, housings for water pumps, thermostats and electronic valve pumps, oil coolers, water pump impellers, heater core end caps, snap-fit electrical terminals and molded-in-place gaskets.

### Electrical and Electronics

Amodel® PPA's excellent electrical properties make it ideal for connectors, switches and other applications where it functions as an electrical insulator. Additional applications include controller housings and components used in electrical motors.

Flame-retardant grades are compatible with SMT processing such as infrared reflow and vapor phase soldering, and halogen-free flame-retardant (HFFR) grades are available. Light-stabilized, high-reflectivity white PPA grades have been optimized for reflector cups used to manufacture LEDs.





# Amodel® PPA Product Line

Our broad family of Amodel® PPA resins is built on three main base resins, each offering distinct product and processing features. Glass fibers, impact modifiers, minerals and other materials are compounded with these base resins to create an extensive selection of grades that offer a wide range of cost and performance options.

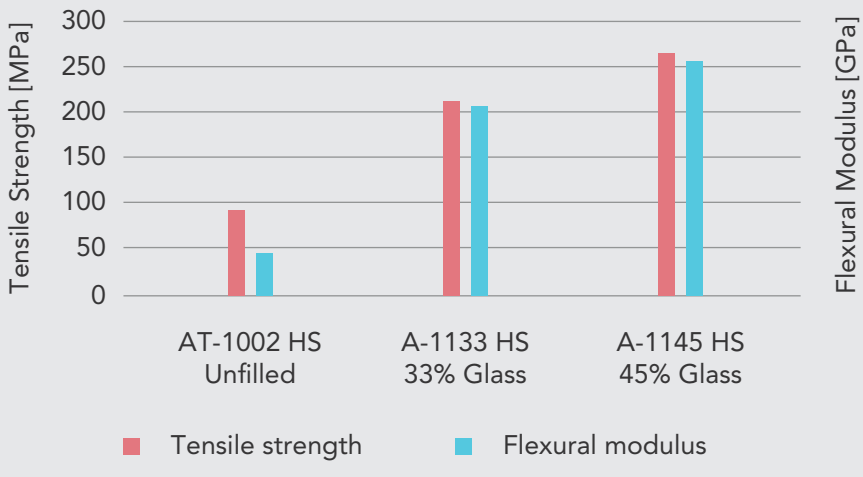
## Amodel® PPA base resins

| | | | Glass Transition Temperature | | Melting Temperature | |
|---|---|---|---|---|---|---|
| Base Resin | Processing | Description | °C | °F | °C | °F |
| 1000 Series | Hot oil moldable (mold temp > 135 °C) | Delivers the highest long-term thermal performance. High-flow HFZ grades available. | 123 | 253 | 313 | 595 |
| 4000 Series | Hot water moldable (mold temp < 100 °C) | Provides the fastest crystallization for short cycle times. Compatible with SMT processing. High-flow HFZ grades available. | 100 | 212 | 325 | 617 |
| 6000 Series | Hot water moldable (mold temp < 100 °C) | Excellent processing characteristics and surface appearance. | 88 | 190 | 310 | 590 |
| 8000 Series | Hot oil moldable (mold temp > 145 °C) | Best-in-class chemical and thermal resistance | 135 | 275 | 325 | 617 |
| 9000 Series | Hot oil moldable (mold temp > 170 °C) | Highest glass transition temperature. Delivers the best mechanical and electrical performance around 150-200 °C. | 165 | 340 | 325 | 617 |
| R1-000 Bios Series | Hot oil moldable (mold temp > 145 °C) | Low moisture absorption. Excellent chemical and mechanical properties. Partially bio-sourced | 135 | 275 | 315 | 599 |

## Glass Fiber Reinforced Grades

Glass fiber reinforcement significantly improves strength and stiffness, short-term thermal properties, and longterm resistance to creep and fatigue. Glycol-resistant grades are available.

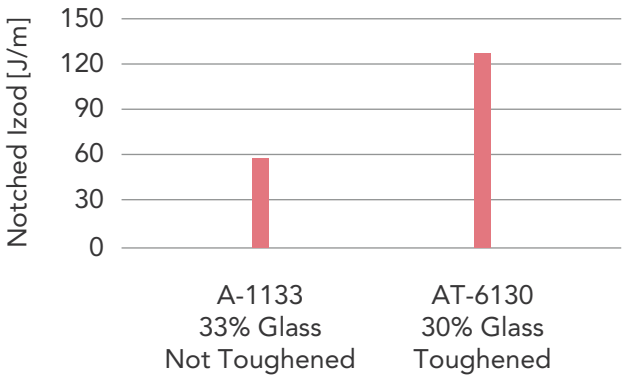
Strength and stiffness comparison
ASTM test method



## Impact Modified Grades

Toughened Amodel® PPA grades are compounded with impact modifiers to increase impact resistance. Unfilled toughened grades offer higher impact resistance than glass fiber reinforced grades.

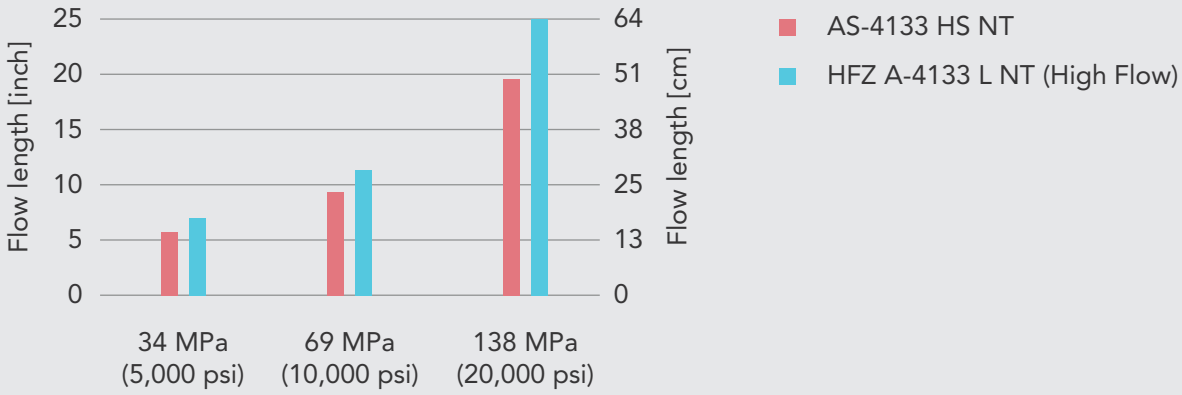
Improved impact resistance
ASTM test method




## High-Flow Grades

Amodel HFZ grades improve molding of thin-walled, complex parts such as electronic components.

Spiral flow of Amodel® PPA
Tested at a thickness of 1.6 mm (0.064 inch)




## Mineral and Mineral/Glass Fiber Reinforced Grades

Minerals reduce warpage and differential shrinkage, resulting in more uniform parts with dimensional stability.

### Coefficient of Linear Thermal Expansion ( CLTE )
### ASTM Test Method

| | 0 °C to 100 °C | | 100 °C to 200 °C | |
|---|---|---|---|---|
| Grade | Flow | Transverse | Flow | Transverse |
| Amodel® A-1133 HS, 33% glass, without mineral | 24 | 55 | 27 | 115 |
| Amodel® AS-1566 HS, 66% glass, with mineral | 17 | 40 | 17 | 72 |

Units: ppm / °C

# Flame-Retardant Grades

Flame retardant grades are compatible with SMT processing techniques such as infrared reflow and vapor phase soldering. Halogen-free flame retardant (HFFR) grades are available.

## UL 94 Rating and Relative Thermal Index (RTI)

| Grade | Thickness [ mm ] | UL 94 Rating | Relative Thermal Index | | |
|---|---|---|---|---|---|
| | | | Electrical | Mechanical with Impact | Mechanical without Impact |
| Amodel® AFA-4133 V0 Z | 0.75 | V-0 | 130 °C | 130 °C | 130 °C |
| | 1.5 | V-0 | 130 °C | 130 °C | 130 °C |
| | 3.0 | V-0 | 130 °C | 130 °C | 130 °C |
| Amodel® AFA-6133 V0 Z | 0.75 | V-0 | 130 °C | 130 °C | 130 °C |
| | 1.5 | V-0 | 130 °C | 130 °C | 130 °C |
| | 3.0 | V-0 | 130 °C | 130 °C | 130 °C |
| Amodel® HFFR-4133 (halogen-free) | 0.75 | V-0 | 140 °C | 115 °C | 115 °C |
| | 1.5 | V-0 | 140 °C | 120 °C | 120 °C |
| | 3.0 | V-0 | 140 °C | 125 °C | 125 °C |

# Electrical Grades

Amodel® PPA's outstanding electrical properties make it ideal for use in connectors, switches and other electrical and electronic applications requiring the material to be used as an electrical insulator.

## Electrical properties

| Grade | Minimum Thickness, mm | Hot Wire Ignition | High-Current Arc Ignition | High-Voltage Arc Tracking | Comparative Tracking Index |
|---|---|---|---|---|---|
| Amodel® AFA-6133 V0 Z 33% glass filled, flame retardant | 0.75 | 0 | 0 | 1 | 1 |

UL performance class ratings vary for each property; visit www.ul.com for definitions.

| Grade | Dielectric Strength (3.2 mm), kV/mm ASTM D149 | Volume Resistivity, ohms*cm ASTM D257 | Comparative Tracking Index, V IEC60112 |
|---|---|---|---|
| Amodel® AE-4133 33% glass filled, organically stabilized | 19 | 5.6E+15 | 600V |
| Amodel® AFA-6133 V0 Z 33% glass filled, flame retardant | 24 | 1.0E+15 | 600V |
| Amodel® AE-9933 33% glass filled, organically stabilized | 19 | 1.8E+16 | 600V |
| Amodel® Bios AE R1-133 33% glass filled, organically stabilized | 20 | 2E+16 | 600V |
| Amodel® Bios HFFR R1-133 33% glass filled, halogen free flame retardant | 20 | 2E+16 | 600V |

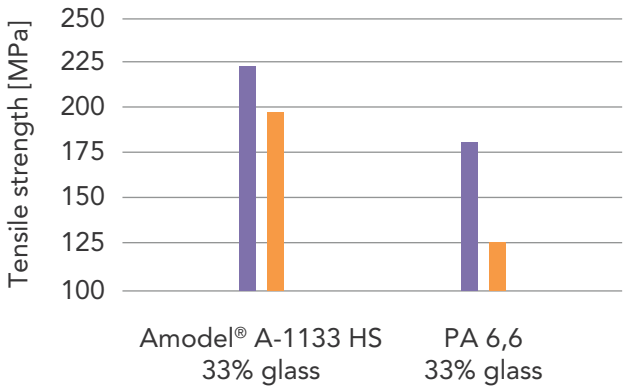
# Get The Performance You Need

Amodel® PPA's broad product family gives you numerous ways to optimize performance, processing and price. Their exceptional thermal, mechanical and electrical properties make them suitable for a wide range of demanding applications including high-temperature automotive applications, housings for high-temperature electrical connectors, LED reflectors, electric and electronic devices and telecommunications.

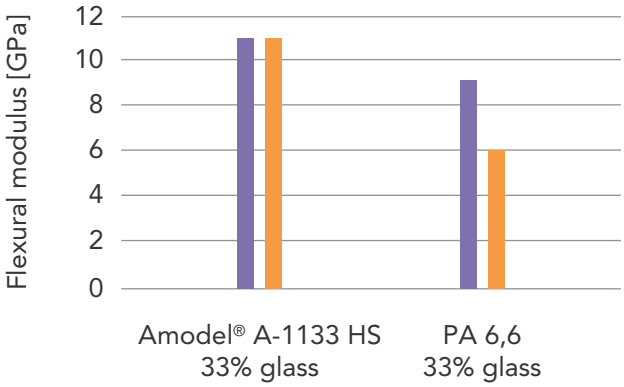
## Lower Moisture Absorption

Humid environments can have a devastating effect on the mechanical properties of standard nylons. Amodel® PPA's lower water absorption rate results in significantly less change in strength and stiffness, even with high levels of humidity.

Effects of moisture on tensile strength
ASTM test method




Effects of moisture on flexural modulus
ASTM test method




Dry As Molded (DAM)

50 % relative humidity

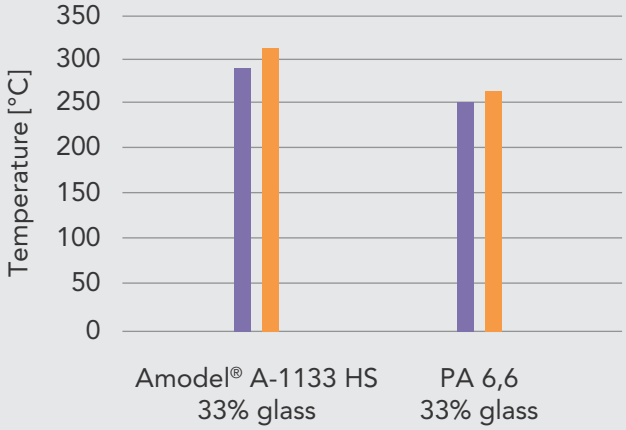
## Higher Heat Resistance

Amodel® PPA boasts heat deflection temperatures (HDT) up to 310 °C (590 °F) and continuous-use temperatures from 120 °C to 185 °C (248 °F to 365 °F).
This makes Amodel® PPA an excellent candidate for replacing metal in high-temperature automotive applications.

HDT at 1.82 MPa

Melting point

Thermal properties comparison
ASTM test method



## Resistant to Fuels, Glycols and Harsh Chemicals

Amodel® PPA's highly aromatic ring structure provides greater resistance to a broader range of chemicals than standard, linear aliphatic nylons, even at high temperatures. This enables automotive, electrical and industrial components to withstand prolonged exposure to harsh chemicals:

- Bio-diesel fuel
- Brake fluid
- Calcium chloride
- Glycols
- Synthetic motor oil
- Road salt
- Transmission fluid
- Zinc chloride

### Chemical resistance

| Reagent | Condition | Amodel® AT-1002 HS[1] | POM[2] | PA 6,6 |
|---|---|---|---|---|
| Hydrochloric acid, 5% to 10% | 23 °C / 1,000 hrs | Excellent | Unsatisfactory | Unsatisfactory |
| Nitric acid, 5% to 10% | 23 °C / 1,000 hrs | Excellent | Unsatisfactory | Unsatisfactory |
| Sulfuric acid, 5% to 10% | 23 °C / 1,000 hrs | Excellent | Unsatisfactory | Acceptable |
| Sulfuric acid, 30% to 36% | 40 °C / 200 hrs | Excellent | Unsatisfactory | Unsatisfactory |
| Sulfuric acid, 30% to 36% | 23 °C / 1,000 hrs | Excellent | Unsatisfactory | Unsatisfactory |
| Hydrofluoric acid, 1% to 5% | 23 °C / 1,000 hrs | Acceptable | Unsatisfactory | Unsatisfactory |
| Zinc chloride, 50% | 23 °C / 200 hrs | Excellent | Unsatisfactory | Unsatisfactory |
| Eagle one chrome wheel cleaner | 23 °C / 200 hrs | Excellent | Unsatisfactory | Unsatisfactory |

[1] Unfilled, toughened and heat stabilized
[2] Polyoxymethylene

# Typical Properties

## Typical properties of selected Amodel® PPA grades
## ASTM test method

| | | Glass Filled | | Structural* | | Toughened | | Flame Retardant | | Electro-friendly** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Property | Units | A-1133 HS 33% GF | A-1145 HS 45% GF | AS-4145 HS 45% GF | AS-1566 HS 66% GF, Mineral | AT-1002 HS Unfilled | AT-6130 HS 30% GF | AFA-6133 V0 Z 33% GF | HFFR -4133 33% GF | AE-4133 33% GF | AE-8935 35% GF | AE-9933 33% GF | Bios AE R1-133 33% GF |
| Tensile strength | MPa | 233 | 259 | 224 | 200 | 83 | 170 | 186 | 165 | 215 | 224 | 199 | 209 |
| | kpsi | 33.8 | 37.5 | 32.5 | 29.0 | 12.1 | 24.6 | 27.0 | 23.9 | 31.2 | 32.5 | 28.9 | 30 |
| Tensile modulus | GPa | 13.4 | 17.2 | 16.1 | 22.8 | 2.8 | 9.3 | 14.5 | 12.6 | 12.6 | 13.2 | 12.6 | 11 |
| | Mpsi | 1.94 | 2.5 | 2.34 | 3.26 | 400 | 1.35 | 2.10 | 1.83 | 1.83 | 1.91 | 1.83 | 1.6 |
| Tensile elongation | % | 2.5 | 2.6 | 2.2 | 1.4 | 11 | 2.8 | 1.6 | 2.1 | 2.5 | 2.5 | 2.1 | 2.8 |
| Notched Izod [ISO test method] | $kJ/m^2$ | 8.8 | 10.3 | 10.0 | 6.6 | 13.0 | 13.0 | 8.0 | 7.5 | 9.2 | 11.5 | 8.4 | 11 |
| | $ft\text{-}lb/in^2$ | 4.2 | 4.9 | 4.8 | 3.1 | 6.0 | 6.0 | 3.9 | 3.6 | 4.4 | 5.5 | 4.0 | 5.2 |
| Un-notched Izod [ISO test method] | $kJ/m^2$ | 49 | 61 | 55 | 44 | 177 | 80 | 44 | 44 | 68 | 76 | 37 | 55 |
| | $ft\text{-}lb/in^2$ | 23 | 29 | 26 | 21 | 84 | 38 | 21 | 21 | 32 | 36 | 18 | 26 |
| HDT, 1.8 MPa | °C | 280 | 281 | 298 | 280 | 118 | 276 | 282 | 300 | 300 | 290 | 304 | 265 |
| | °F | 536 | 538 | 568 | 536 | 244 | 529 | 540 | 572 | 572 | 554 | 580 | 509 |
| Specific gravity | | 1.48 | 1.59 | 1.55 | 1.84 | 1.13 | 1.34 | 1.68 | 1.46 | 1.45 | 1.47 | 1.48 | 1.42 |

* Recommended for applications with wall thicknesses greater than 3 mm.

** Organically stabilised materials: Recommended for applications in contact with metal conductive parts.


Progress beyond

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