

CHEMISTRY THAT MATTERS™



SOLAR: A RAPIDLY EVOLVING INDUSTRY



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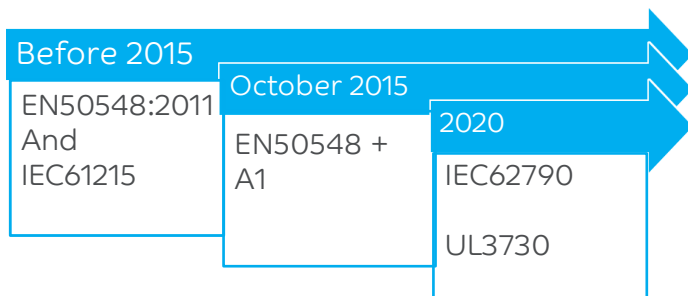
The solar industry is rapidly evolving to meet the efficiency and installed cost goals required for increased adoption.

Trend Toward Improved Tracking Materials

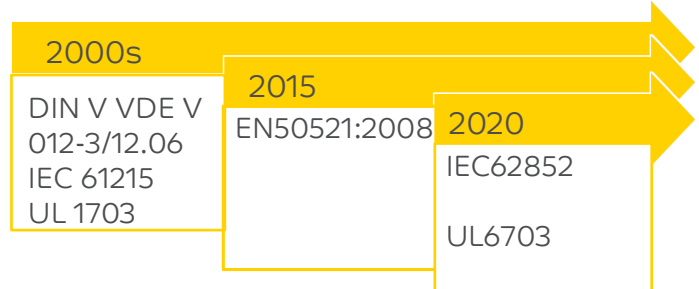
As solar energy becomes more mature and efficient, systems are being designed to handle higher voltage and storage needs. Higher performance also drives changing regulatory requirements for both PV junction boxes and connectors. Emerging standards for each component at higher voltages (1.5kV) are converging toward **CTI (Comparative Tracking Index)** materials capable of meeting Performance Level 0 requirements in multiple system components.

In addition to CTI, other typical performance parameters for materials used in junction boxes and connectors are shown below.

Junction Box Regulatory Overview



PV Connector Regulatory Overview



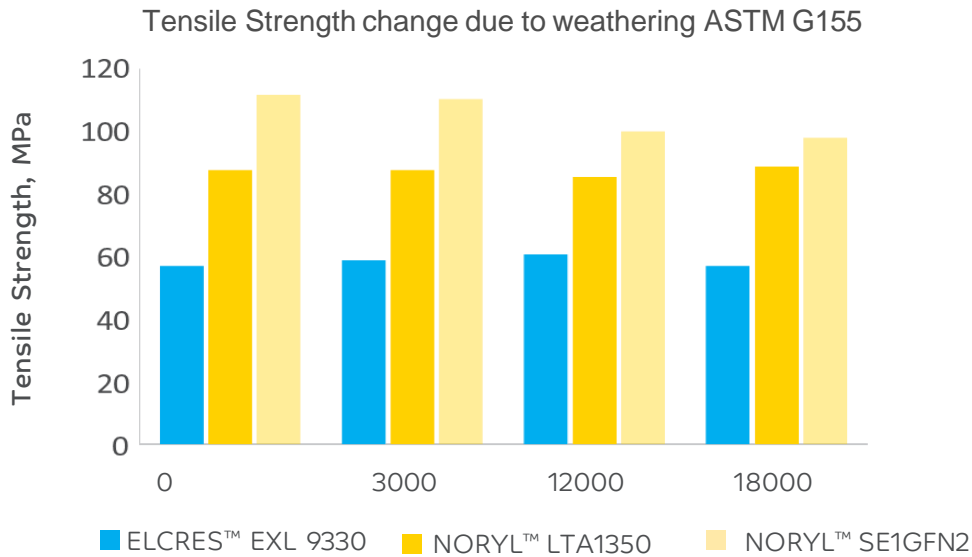
Typical Application Requirements for PV Junction Boxes and Connectors

| Property | Testing standard | Requirement |
|-------------------------------|----------------------|---|
| UV | UL 746C | F1 |
| Comparative Tracking Index | IEC60112 and UL 746A | 600V |
| Inclined Plane Tracking Index | UL 746 | 60min at 1.5kV |
| RTI (electrical) | UL 746 | >= 105 °C |
| Flammability | UL94 | V0 at 1.5mm or lower |
| Hydrolytic Stability | IEC 62852 | 1000hr at 85°C/85% RH |
| Impact | UL 3730 | Pass -35 °C ball drop |
| Weatherability | ISO 4892 | 500 hours followed by either dielectric (connectors) or glow wire (boxes) testing |

Weatherability is key

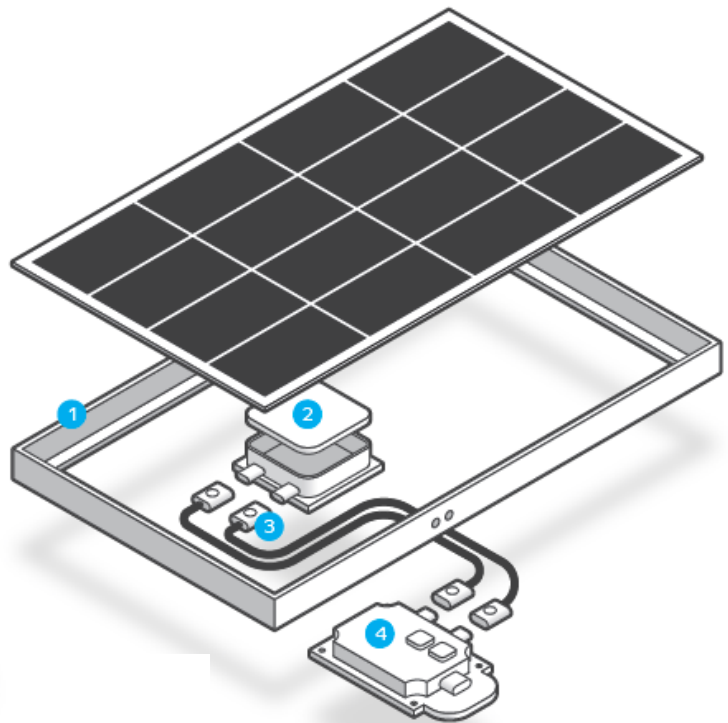
Because of the demands of harsh outdoor environments, UV resistance and weatherability can make all the difference, so SABIC has invested in extended testing for ISO and ASTM weathering standards.

See the weathering chart below for tensile strength at 15,000 hours for three different SABIC specialties solutions.



SABIC Solutions Well-Suited for PV Junction Boxes and Connectors

NORYL™ resins and LNPT™ compounds can offer performance attributes that may meet or exceed many of these regulatory, electrical and weatherability requirements.



- 1 EXTRUDED FRAME:** NORYL resins
- 2 JUNCTION BOX:** NORYL resins
- 3 CONNECTORS:** LNPT™ ELCRES™ EXL resins
- 4 MICRO INVERTER:** NORYL & LNP ELCRES EXL resins

LNPTM EXL PC COPOLYMERS RESINS

LNP EXL resin is a copolymer of polycarbonate and polysiloxane. The remarkable property profile of EXL products provides parts with outstanding impact strength and toughness over a broad range of temperatures, dimensional stability, consistent processability, flame retardancy, hydrolytic & chemical stability and a wide color palette.

SABIC Specialties EXL9330 and EXL9330S Resins

The electrical and flame-retardant performance of our EXL9330 and EXL9330S resins help designers to miniaturize the entire system by creating thin-wall parts, moving conductors closer together, and integrating junction box systems, helping to drive down solar energy system costs and increase efficiency.

While EXL9330 resin can be used in designs requiring comparative tracking index (CTI) PLC-3 rated materials, EXL9330S can suit designs that demand more stringent CTI PLC-2 properties and UL94 V0 at 0.8mm.

Introducing LNP ELCRES™ EXL9334P Resin

The new LNP ELCRES EXL9334P grade surpasses these materials in its electrical performance with a CTI PLC-0 rating (CTI=600V). Compliance with this tough standard means that EXL9334P resin is suitable for PV connectors, delivering highest CTI level to support emerging 1.5KV systems.

It has an FR UL94 V0 rating at 1.2 mm and provides exceptional low- temperature ductility, heat resistance, good hydrolysis resistance and a UL746C F1 rating.

Lower CO₂ footprint offerings are available through the use of PCR PC or renewable feedstock to give ISCC+ certified materials based on the mass balance approach.

FEATURES & POTENTIAL BENEFITS

LOW TEMPERATURE DUCTILITY

Low temperature ductility up to -60C (upgrade vs. standard PC, impact modified PC, or PC/ABS)

HIGH TEMPERATURE RESISTANCE

Relative thermal Index up to 130°C

WEATHERABILITY & HYDRO STABILITY

Retention of properties upon UV, humidity and heat exposure

CHEMICAL RESISTANCE

Upgrade versus PC & PC/ABS with amorphous shrinkage



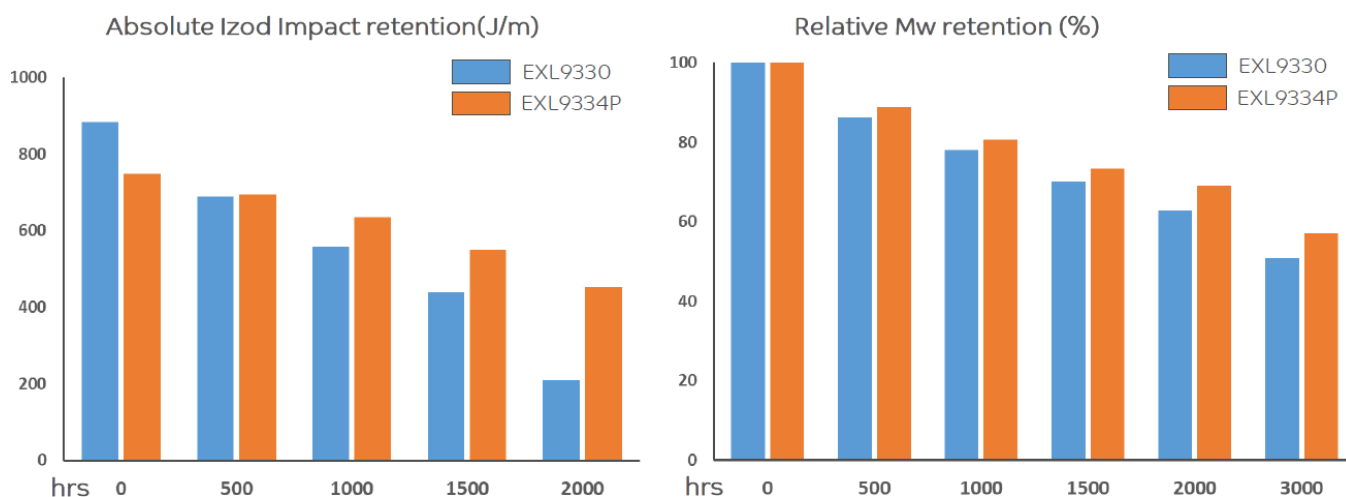
LNPT™ EXL COPOLYMER RESINS

REPRESENTATIVE DATASHEET PROPERTIES FOR POTENTIAL PHOTOVOLTAIC APPLICATIONS

| Test | Units | EXL9330 | EXL9353RCC * | EXL9330S | EXL9334P |
|---|-------------------|---------|--------------|----------|----------|
| Izod Notched Impact - ISO180/1A (23°C) | KJ/m ² | 70 | 73 | 75 | 61 |
| Izod Notched Impact - ISO180/1A (-30 °C) | KJ/m ² | 55 | 45 | 50 | 59 |
| HDT (ASTM) 0.45 MPa, Unannealed 3.2 mm | °C | 134 | 128 | 139 | 136 |
| Flex Modulus - ASTM D790 1.3 mm/min, 50mm span | MPa | 2060 | 2200 | 2150 | 2110 |
| Flame UL 94 V0 | mm | 1.5 | 1.5 | 0.8 | 1.2 |
| Flame UL 94 5VA | mm | 3 | 3 | 2.5 | 3 |
| CTI - UL 746A | PLC | 3 | 3 | 2 | 0 |
| RTI Electrical - UL 746 | °C | 125 | TBD | 125 | 130 |
| Weatherable - UL 746C (black data represented) | | F1 | F1 | F1 | F1 |

* LNP ELCRIN™ EXL9353RCC resin is based on 50% PCR PC available in custom colors

Performance retention after Heat Humidity 85°C & 85%RH



NORYL™ RESINS

NORYL resins are built from a blend of polyphenylene ether (PPE) and polystyrene resins, along with additional additives such as glass fibers and flame retardants. NORYL resins feature industry-leading low specific gravity, moisture absorption and hydrolytic stability.

The chemistry inherent to the PPE molecules creates mechanically strong polymers and are inherently flame retardant and high heat stable, char forming, and lightweight. In addition, good resistance to typical acids and bases is a common feature of the PPE polymer and its blends with polystyrenes.

NORYL resin generally exhibits excellent electrical properties that remain stable over a wide range of temperature, humidity and frequency variations. This stability, together with a fine-tuned balance of thermal, flame retardance and impact properties, makes NORYL resin a potentially excellent candidate for junction boxes or solar tracker enclosures

NORYL V0150B resin is a workhorse grade in solar junction boxes, offering excellent balance of properties. For thinner wall parts at similar RTI value, NORYL PX9406P resin has been successfully used. For products requiring even higher RTI values of 125°C while still maintaining CTI, NORYL LTA6020 resin can be a good candidate. NORYL SE1GFN2 resin can be positioned if higher stiffness is desired while maintaining other properties.



FEATURES & POTENTIAL BENEFITS

THIN WALL FLAME RETARDANT

V0 flame ratings down to 0.75mm, 5VA down to 2mm

DIELECTRICAL PROPERTIES

Inclined Plane Tracking (IPT) up to 2 KV

WEATHERABILITY & HYDRO STABILITY

Retention of properties upon UV, humidity and heat exposure

DIMENSIONAL STABILITY

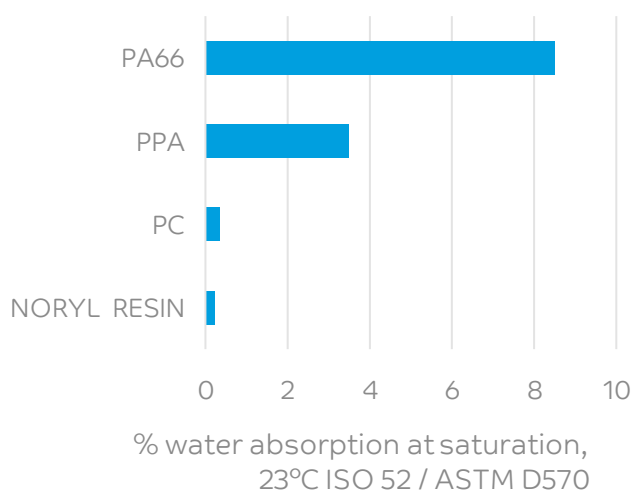
Low warpage and no dimension/stiffness changes in humid environments

NORYL™ RESINS

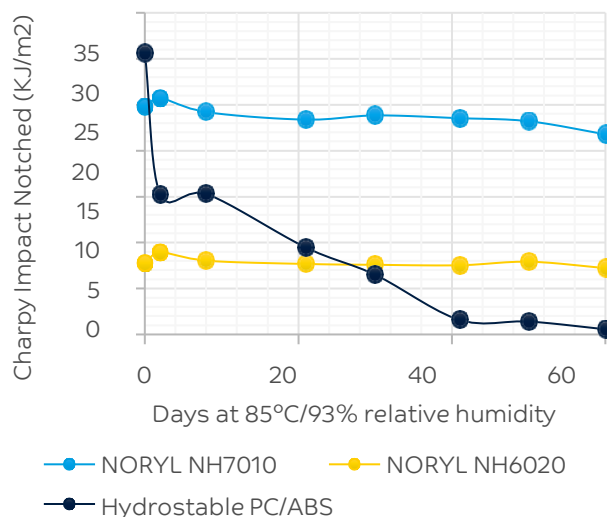
REPRESENTATIVE DATASHEET PROPERTIES FOR POTENTIAL PHOTOVOLTAIC APPLICATIONS

| Test | Units | V0150B | PX9406P | NH6020 | LTA6020 |
|--|-------------------|--------|---------|--------|---------|
| Izod Notched Impact - ISO180/1A (23°C) | KJ/m ² | 13 | 13 | 8 | 16 |
| Izod Notched Impact - ISO180/1A (-30 °C) | KJ/m ² | 5 | 8 | 5 | 8 |
| HDT (ISO 75) 1.8 MPa, Unannealed 3.2 mm | °C | 132 | 117 | 125 | 125 |
| Flex Modulus – ISO 178 | MPa | 2500 | 2500 | 2700 | 2580 |
| Flame UL 94 V0 | mm | 1 | 0.75 | 0.8 | 1.5 |
| Flame UL 94 5VA | mm | 1.8 | 2.5 | 2.5 | 2.5 |
| CTI - UL 746A | PLC | 2 | 2 | 0 | 2 |
| RTI Electrical - UL 746 | °C | 110 | 105 | 110 | 125 |
| Weatherable - UL 746C (black data represented) | | F1 | F1 | F1 | F1 |
| Inclined-Plane Tracking ASTM D2303 | | 2KV | 2KV | 2KV | 2KV |

MOISTURE UPTAKE: DIFFERENT RESINS



HYDROLITIC STABILITY OF NORYL RESIN



LNPTM COMPOUNDS WEAR AND FRICTION SOLUTIONS LUBRILLOY ALLOY TECHNOLOGY

As one of innovation trends in the photovoltaic market, some manufacturers have chosen to install moving solar panels, which can increase their efficiency by changing their orientation to the sun.

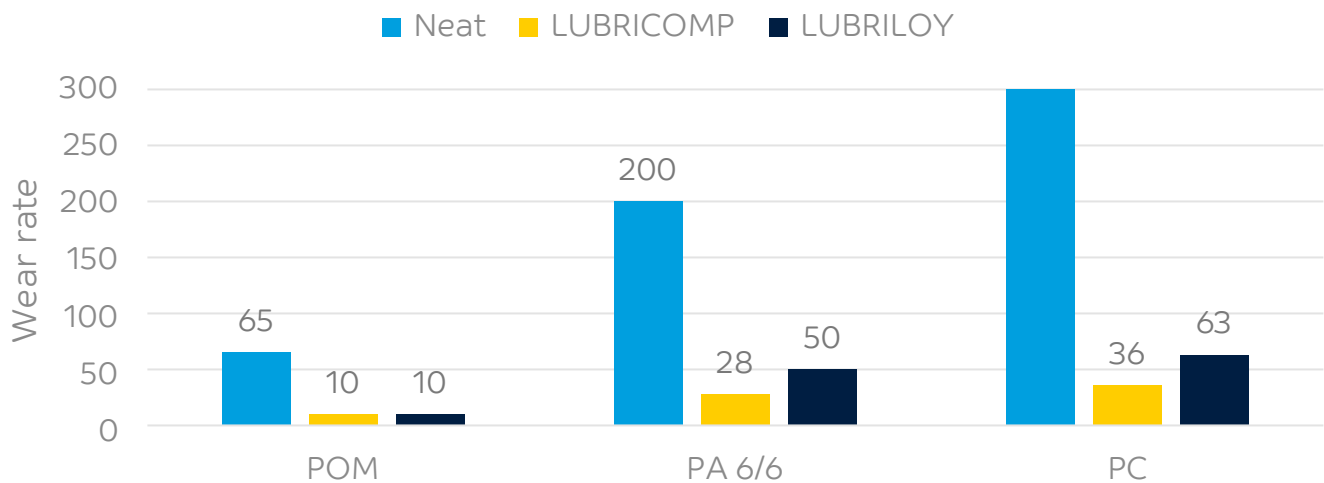
Plastic gears *and bushings* have positioned themselves as serious alternatives to traditional metal gears in a wide variety of applications. They *require less maintenance*, have less weight, lower inertia and run much quieter than their metal counterparts. Plastic gears often require no lubrication or can be compounded with internal lubricants such as PTFE or silicone. These *materials* are also resistant to many corrosive environments.

Since 1994, SABIC has developed a portfolio based on a variety of thermoplastic resins in combination with different internal lubricants. Reinforcements can also be added such as glass, aramid, or carbon fiber to enhance abrasion resistance, mechanical strength and conductivity.



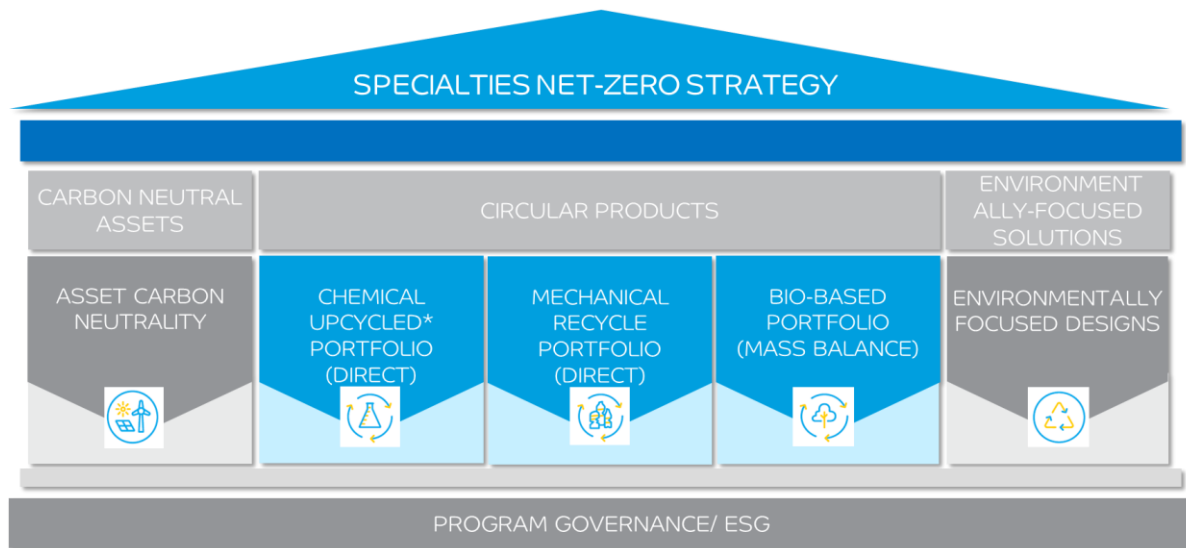
LNP LUBRICOMP™ & LUBRILLOY™ Wear & Friction solutions for solar tracking/moving systems

THRUST WASHER WEAR VS. STEEL (50 FPM, 40 PSI, RT)



SUSTAINABLE SOLUTIONS

SABIC Specialties circular ambition is driven by the growing industry desire for sustainable solutions and fueled by our vision to compound the answer.

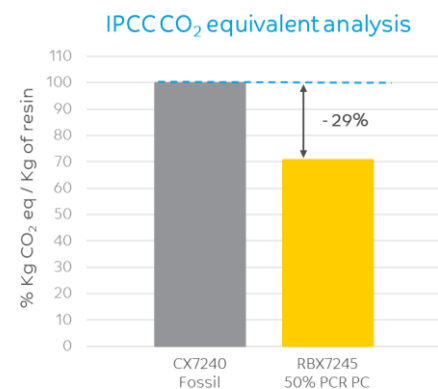
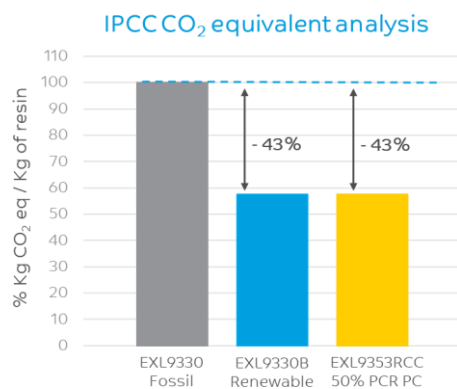


LNP ELCRIN EXL9330B resin with 57% renewable, bio-based feedstock is an ISCC+ certified material based on mass balance approach



MECHANICAL RECYCLING

- ✓ Hybrid solution; mix with virgin material
- ✓ PCR content certified by SCS Global
- ✓ Comparable properties to virgin grades



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SABIC MATERIAL FINDER
Find the right Specialties material
for your application ▶



ELECTRICAL
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