CHEMISTRY THAT MATTERS™

LASER WELDING

WITH SABIC'S SPECIALTY THERMOPLASTICS

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COMBINING SPECIALTY THERMOPLASTICS EXPERTISE WITH IN-DEPTH KNOWLEDGE OF THE INDUSTRY TRENDS, SABIC'S SPECIALTIES BUSINESS IS COMMITTED TO KEEPING ITS CUSTOMERS AT THE LEADING EDGE OF MATERIALS AND PROCESSING TECHNOLOGIES.

SABIC's Specialties business offers a portfolio of high-performance engineering thermoplastic resins, compounds and composites. Our broad portfolio includes specialty compounds, with our range of branded materials such as LNP™, NORYL™, ULTEM™, and EXTEM™ products.

Together with extensive materials processing expertise, SABIC's Specialties business is committed to helping you solve your material challenges.

LASER WELDING as assembly technology

Laser welding is widely used in Mobility, Medical Devices, Industrial and Consumer Electronics for the joining of thermoplastic polymers. This welding technique offers a friction and chemical free assembly with significant 3D-design freedom when compared to other techniques and is able to meet customer specific requirements such as IP65 leak tightness.

Benefits of laser welding:

- Increases design freedom
- Joining without chemicals
- Friction free assembly
- Fast and precise
- Reproducible weld quality
- Reduced assembly stress
- Highly local heating
- Clean (flash free) joints
- Narrow weld lines
- Welding compatible with complex 3D-designs

Drawbacks of laser welding:

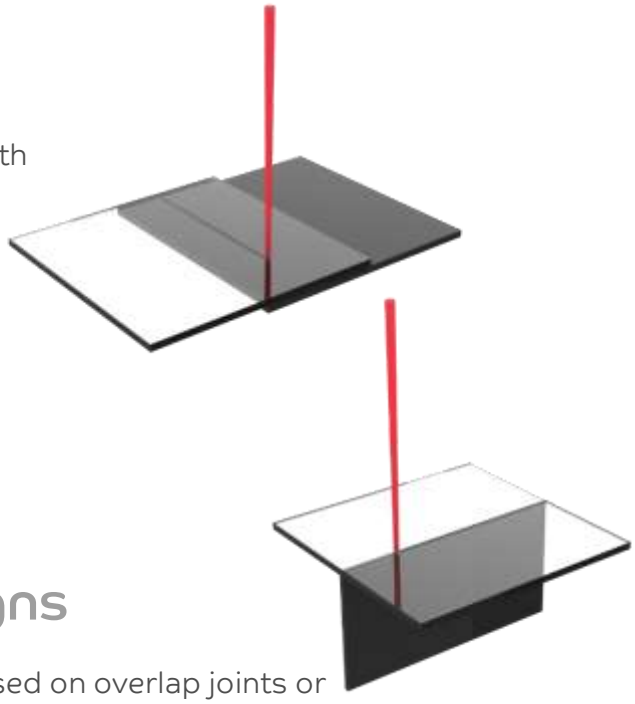
- Requires tailored laser setup
- Requires laser compatible materials

Laser welding eliminates the use of consumables as adhesives and screws for mechanical assemblies and excessive heating compared to other plastic welding techniques like hot plate-, vibration– and ultrasonic welding. The focused energy of the laser eliminates risks of damaging, e.g., electronic components, and minimizes the reject rate of assembled applications.

Laser welding offers many benefits over alternative assembly techniques.

LASER WELDING process and requirements

In a laser transmission welding process, the laser travels through the transparent part to reach the surface of the absorbing part where the laser beam radiation is converted into heat, melting both thermoplastic parts as a result. The melted polymers bond to each other, creating a firm joint.



Process and material requirements

- Typical operating window: 0.8—1.1 µm wave length
- NIR light Transmissive part
- NIR light Absorbing part
- Thermoplastic material compatibility
- Clamping of parts
- Material compatibility

LASER WELDING joint designs

Laser transmission welding joints are typically based on overlap joints or T-joints, where many derivates are being used in the industry. Choice of weld seam design depend on stresses from external factors that are applied to the application and/or weld seam.

Laser welding is provided with different technologies such as: contour welding, (semi) quasi-simultaneous welding, mask welding and radial welding where either the laser or the parts make the movement during the assembly process to generate the desired weld.

As the process, design and materials should be aligned, SABIC Specialties advice would be, to be involved into the project in an early stage to provide the best support possible on product possibilities.

Colors in LASER WELDING

Colorants can affect the degree of complexity for laser transmission welding as it affects the transmission, reflection and/or absorption. SABIC Specialties has the capabilities to develop tailor made solutions suitable for laser welding processes including white to white.

Color matching purposes could be:

- Invisible weld line
- Hiding the inside of an application (e.g. electronics)
- Make it more aesthetical pleasing

LASER WELDING potential fit industries

Consumer electronics

Shaver

Pool light

Cosmetics

Smartwatch

Automotive

Car keys

High performance connectors

ADAS systems

Infrastructure

Street lighting

Drinkwater pump

Medical Devices

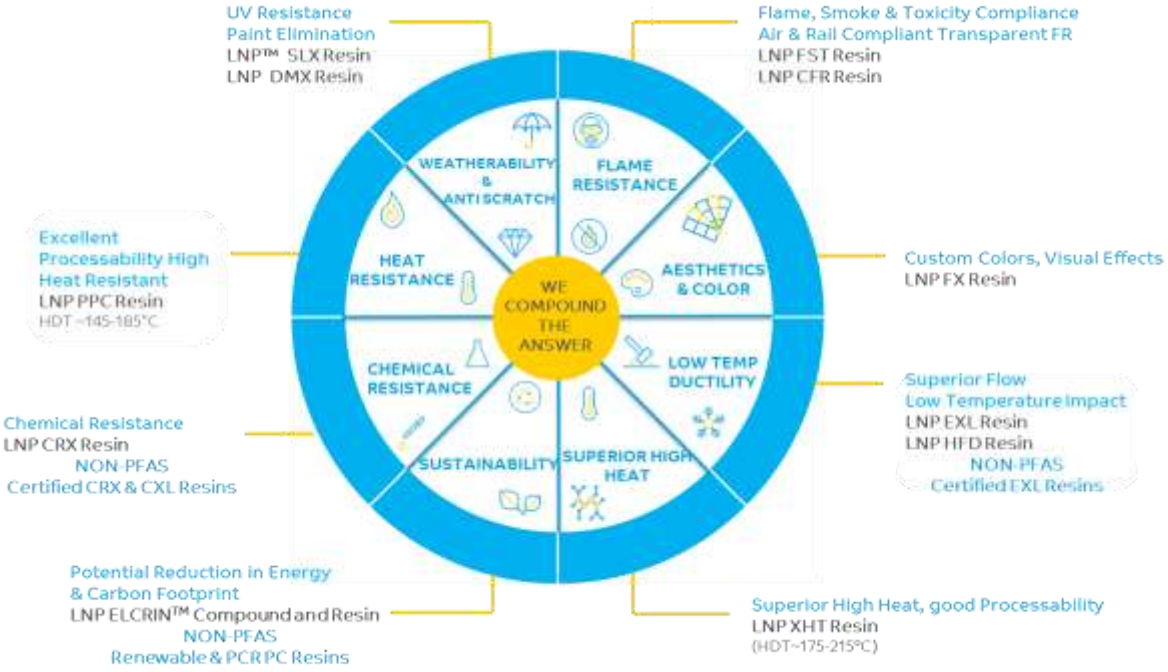
Syringes

Microfluidics

Catheters

Insulin dosing housing

LNP™ Copolymers



All LNP Copolymers are excellently suitable for laser welding processes and offer additionally enhanced properties, including post-consumer recycled (LNP **ELCRIN compound and resin**) grades, expanding customers possibilities in application development.

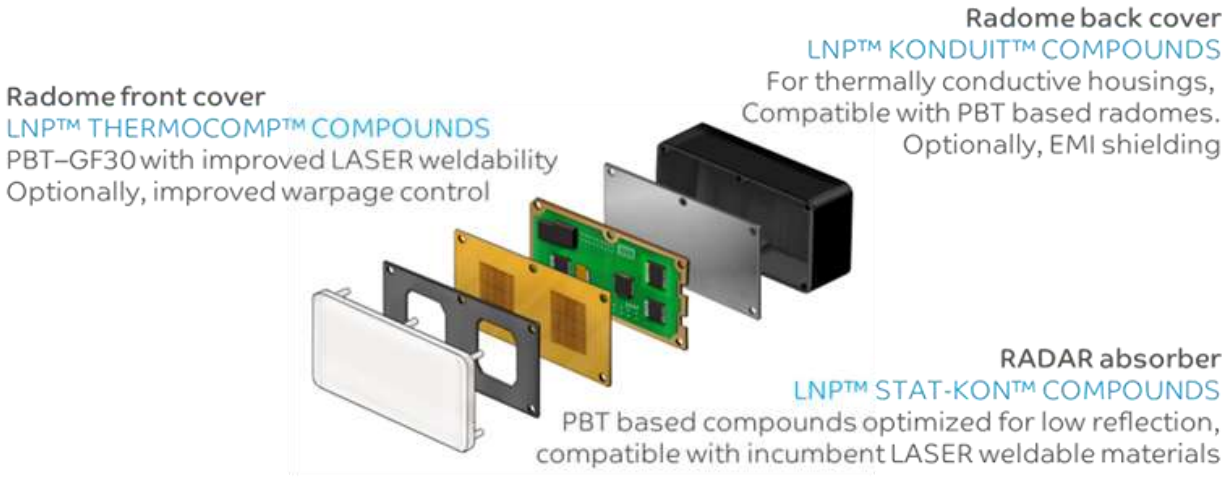
> LNP Copolymer are versatile in terms of laser welding.

LNP™ compounds

LNP compounds are known for their high performance, versatility, and reliability, making them a popular choice in various industries such as electrical and electronics, consumer goods, and industrial products.

LNP™ COMPOUNDS	
ELCRIN™	Sustainability
FARADEX™	EMI shielding
KONDUIT™	Conductive (thermal)
LUBRICOMP™	Wear & friction
LUBRILOY™	Wear & friction
STAT-KON™	Conductive
STAT-LOY™	Conductive
THERMOCOMP™	Structural, Circuit solutions
THERMOTUF™	Impact improvement

LNP compounds have wide range of portfolio as shown in the table. The nature of laser transmittance properties of the material determines it used as laser transparent part or laser absorbing part. It is also worth to be mentioned that the tailored-made laser weldable materials are also option for customers.



LNP THERMOCOMP 6F006 LNP compound is a 30% glass fiber filled PBT/PC copolymer-based compound, which has been optimized for LASER welding technology. Added features of this material include: infrared transparency, high modulus, improved warpage control, and optionally, a black color targeted for LASER transparency or for LASER absorption.

> LNP™ Compounds offer LASER weldability with unique material properties such as thermal conductivity.

NORYL™ resins

The NORYL resin family consists of SABIC's polyphenylene ether (PPE) blended with: HIPS, PP, PA, or TPE, select additives and fillers. These resins exhibit a broad range of properties for application in water management, automotive, electrical, solar, energy storage, building &construction, appliances and more.

Water management

NORYL global potable water resins, such as **NORYL WM330G** (PPE/PS/GF30) , are compliant with KTW-BWGL and provide additional benefits such as weight reduction, very low water uptake and long-term property retention at elevated temperatures and chemical exposure.

Automotive

The NORYL resin portfolio for EV combines the inherent benefits of PPE resin (good electrical properties, excellent hydrolytic stability, long-term dimensional stability, low specific gravity, and acid resistance) with the impact resistance, flow, and processability of high impact polystyrene (HIPS). NORYL resins such as **NHP6011** (25% transmission at 1 mm) and **NHP6012** are developed to address new requirements for EV battery modules and housings.

Solar

NORYL resins exhibit 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 and impact properties, make NORYL resins excellent candidates for demanding solar applications. Potential offerings: unfilled **NORYL V0150B** and **LTA6020** resins to its **NORYL SE1GFN2** (GF20).

NORYL resins can be used for laser welding processes by having sufficient laser transparency at different thicknesses (transparency is grade specific).

> NORYL™ resins are suitable for LASER welding with a fit in various market segment which demanding

High heat resins

ULTEM™ resin, a polyetherimide (PEI), and **EXTEM™ resin**, a Thermoplastic Polyimide (TPI), can help enable design freedom for demanding applications. They provide a unique combination of high heat resistance, dimensional stability, stable dielectrics, strength stiffness (over temperature) and offers inherent halogen-free FR, IR transparency, hydrolytic stability, and chemical resistance.

ULTEM and EXTEM resins are used in industries such as Infrastructure , Mobility and Electronics in a broad range of applications. Renewable **biobased ULTEM** resins are available, offering sustainability benefits while delivering the same high performance as incumbent ULTEM materials.

High inherent laser transparency

Unreinforced resins, such as **ULTEM 1000** and **EXTEM XH1015UCL resin** provide high laser transparency (90% even at 3 mm) being a great candidate for laser welding processes. Also, alternative grades with glass fiber loadings up to 45% still offer sufficient laser weldability at lower thicknesses (up to 1 mm). Weld strengths may reach as high as with tailored glue systems.

ULTEM resins are available in IR-transparent optical black color that does not affect the laser transparency of the resin.

Blends like **ULTEM DT1810EV** provide improvement on material compatibility, allowing to laser-weld ULTEM resins with other polymer types like PBT or PC.

Water tap cartridge

ULTEM and **EXTEM** resins have excellently compatibility with respect to laser welding and are well suited for demanding applications in market segments such as Water Management, where they can potentially serve as a metal replacement. For example, when considering water tap cartridges, the thermoplastic components used are typically small complex designs that require high temperature resistance, hydrolytic and dimensional stability.

Cartridge For tap water. Well suited for use of ULTEM resin

> LASER weldable ULTEM and EXTEM resins can serve as enablers for designing intricate parts.

Services

- Inhouse laser welding trials and transmission measurements
- Fast Formulations for product optimization
- Color match for branding and application uniqueness
- Material compatibility studies
- Laser marking
- Sampling services (granules and injection molded parts)

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LNP021-A4-250120-EN-W