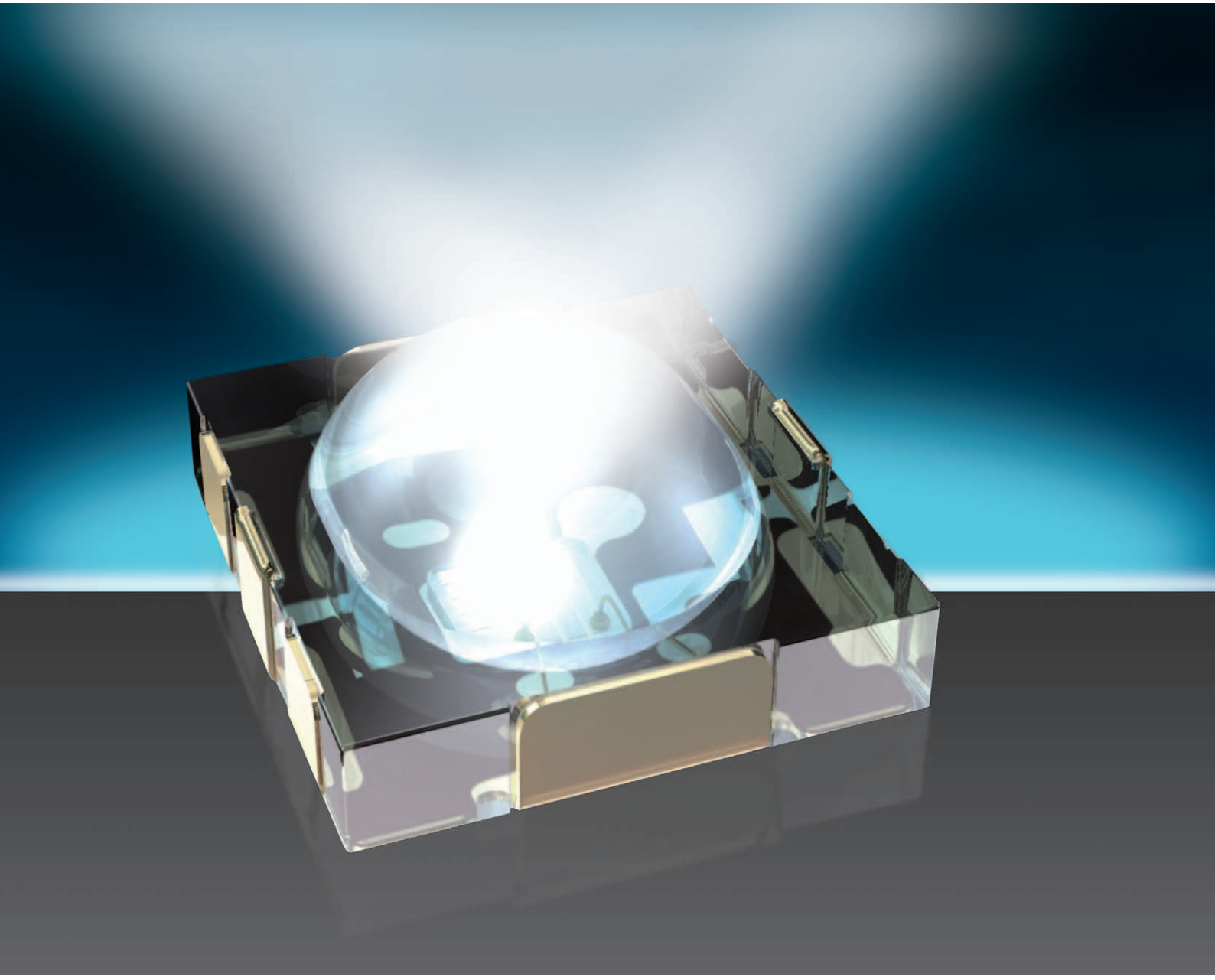
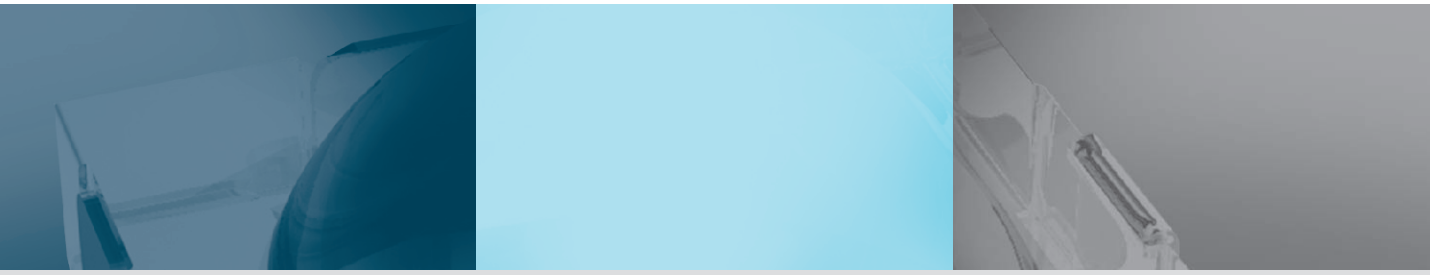
Heraeus



LED Materials

All you need for LED assembly

LED Materials
All you need for LED assembly



With over 160 years of materials expertise, Heraeus is a leading provider of high-tech industrial precious metals and specialty metals products. The wide-range of products developed for LEDs are provided by the diverse Heraeus Business Units who are strategically partner with the LED industry to provide the go materials needed for LED assembly, from start to finish.

High-tech materials for light-emitting diodes
The Business Unit Bonding Wires manufactures highly reliable gold bonding wires for LED technology featuring high strength and good loop stability.

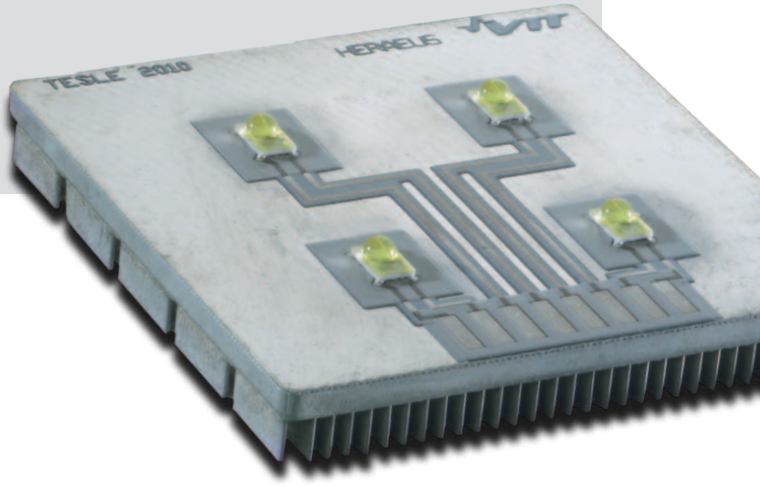
For conductors and insulation layers (dielectrics), thick film pastes from the Business Unit Thick Film offer high flexibility and reduced materials consumption; a viable alternative to MCPCB (Metal Core Printed Circuit Board).

The Business Unit Microbond Assembly Materials is a leading manufacturer of conductive adhesives, solders, and sintering materials for a wide variety of die attach applications. The sintering materials exhibit superior thermal and electrical conductivity which results in increased reliability and operating life for devices. These properties are especially advantageous for ultra bright LED's which have increased power density requirements.

Stamped circuit boards supplied by the Business Unit Packaging Technology are punched, laminated, coated, ultrathin strips which are tailor-made to customer specifications to suit a variety of applications. They act as electrically and thermally conductive carriers for electronic components such as LED modules.

The PVD process is a key technology for producing ultrathin and homogeneous layers. Heraeus counts as one of the world's largest and most experienced suppliers of sputter targets and evaporation materials and the Business Unit Electronics is a competent partner for customer-specific coating solutions.

Heraeus products for the LED industry
- Thick film pastes (TFD-TH)
- High performance die attach materials (CMD-AM)
- Bonding wires (CMD-BW)
- Substrates and roll clad strips (EMD-PT)
- Sputter targets (TMD-ELC)



IAMS directly printed on Al heat sink

Thick Film Materials

TFD-TH

Insulated Aluminum Materials System (IAMS)
The new IAMS from Heraeus is a thick film based material system and designed as an insulation system for aluminum substrates. All materials can be fired at less than 580°C, and it is compatible with several aluminum grades.

Its unique glass system minimizes bowing on aluminum while providing high dielectric breakdown strength and good thermal conductivity. The versatility of this system allows quick and inexpensive design changes and lower material consumption compared to the traditional MCPCB (Metal Core Printed Circuit Board) system.

Typical Heat Dissipation for High Power Application
- High power LED substrates (> 1W input)
- Concentrative photovoltaic (CPV)
- Power electronics
- Heaters

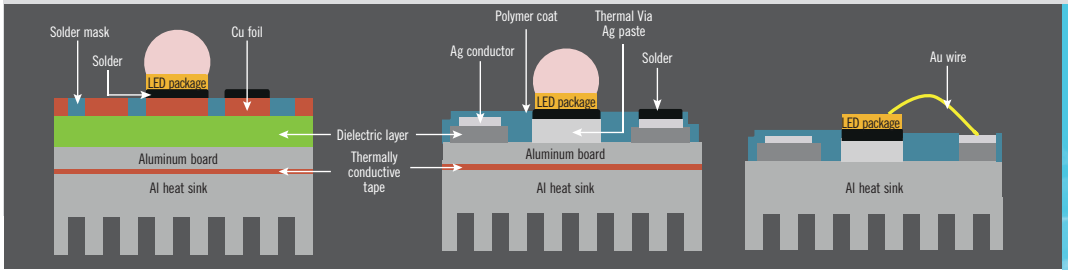
Thick Film Technology Benefits
Selective, additive deposition
- Lower material consumption
- Possibility to create circuits on heat sinks
- Possibility to create circuits on non-planer heat sinks

Versatility
- Quick and inexpensive design changes
- Suitable for a variety of substrate materials
- Compatible with Pb-free solders and fine Au wire bonding

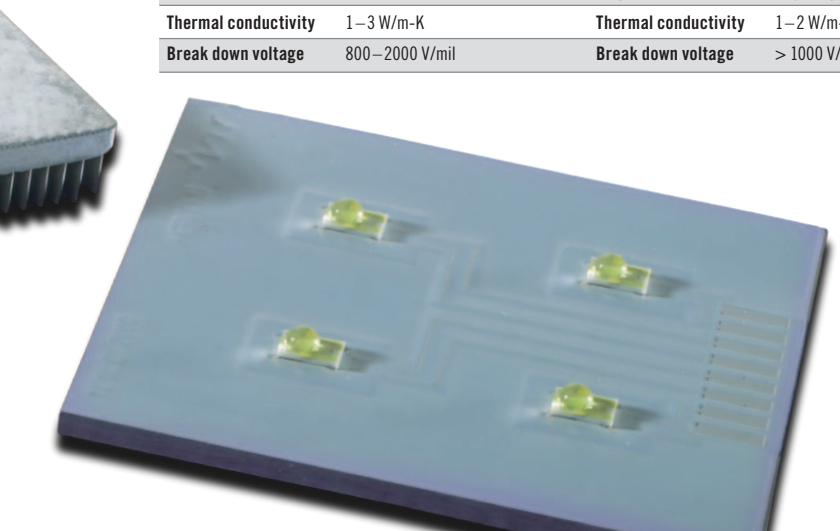
Simplified bill of materials
- Single part dielectric system

Inert glass/metal system
- No flammability issues

Environmentally friendly
- Pb-free, RoHS compliant/REACH compliant



MCPCB		Insulated Aluminum Materials System (IAMS)		
Base plate	Al or Cu (1.2 mm or thicker)	**Base plate**	Al (1.2 mm or thicker) or direct print on Al heat sink	
Dielectric layer	Filled epoxy (120–300 µm)	**Dielectric layer**	IP 6075 (50–100 µm)	**Process** 550–580°C dwell time 2–3 min
Conductor	Cu foil (35–350 µm)	**Conductor / Via paste**	C 8829 B (C 8710 M Solder pad paste) (8 – 12 µm Ag)	**Process** 490–550°C dwell time 5–8 min
Solder mask		**Polymer coat**	Polymer paste (30–50 µm)	
Thermal conductivity	1–3 W/m-K	**Thermal conductivity**	1–2 W/m-K	
Break down voltage	800–2000 V/mil	**Break down voltage**	> 1000 V/mil	



Microbond Assembly Materials

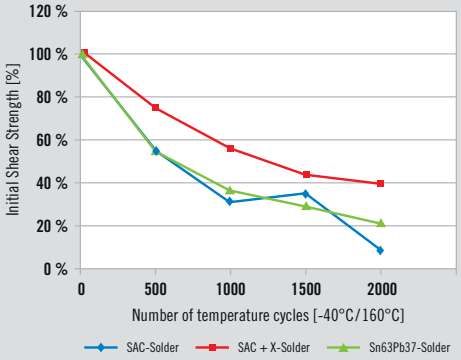
CMD-AM

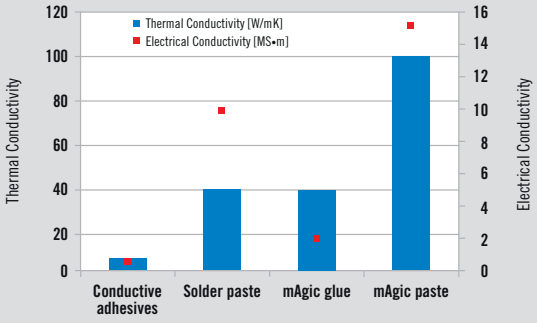
Materials for LED Die Attaching

As a leading supplier of die attach materials Heraeus offers a big variety of products with tailored properties for LED at tach on chip carriers. The low to mid power LEDs industry are served by our well established conductive adhesives for many years. High power LEDs or multichip modules require an advanced higher thermal conductivity and thermal stability of the die attach materials. Operation temperatures up to 100°C can be covered by conventional SAC solder, but for advanced reliability and higher LED operation temperatures Heraeus developed and qualified SAC+X, halide free, lead free solder pastes so called InnoRel products (Innolot and HT1).

Microbond Silver Interconnect

Additionally, our innovative mAgic glues and pastes will lead to improved life time and reliability of LED device by providing outstanding electrical and thermal conductivity. These properties of our novel sintering materials guaranty a longer operation time not only for high power but also for standard LEDs because of excellent heat transfer.





	Conductive Adhesive	Solder Paste	Sinter Glue	Sinter Paste
Processing temperature [°C]	120 – 150	235 – 255	180 – 200	200 – 250
Composition [%]	83 ± 1.5 Ag	SAC (+X)	90 ± 1 Ag	89 ± 1 AG
Residue free	yes	no	yes	yes
Spec. el. conductivity [MS m]	~ 0.5	~ 10	~ 5	~ 15
Thermal conductivity / [W/m·K]	~ 5	~ 40	~ 40	~ 100
Shear strength @ 25°C [N/mm²]	> 8	> 20	> 10	> 15
Recommended application	Low / Mid Power (< 1W)	High Power / Multichip (> 1W)	High Power / Multichip High reliable LEDs	High Power / Multichip High performance LEDs

Bonding Wires
for LED Assembly

CMD-BW

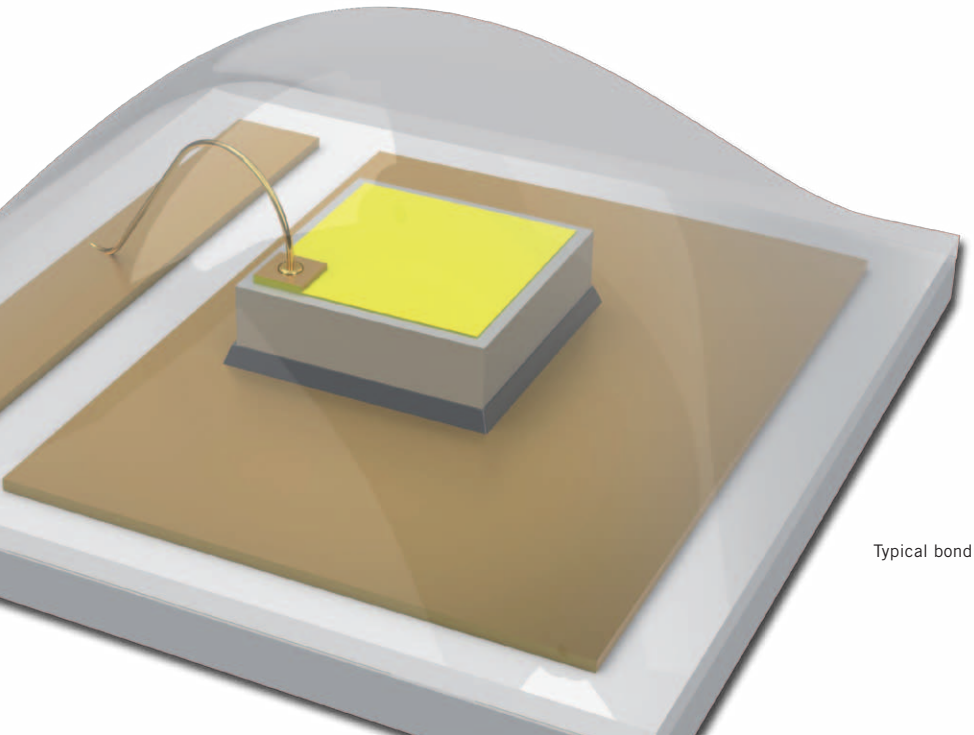
Heraeus offers a wide selection of gold and silver based bonding wire types for ball bonding.

Pure gold wires provide superior performance. Low cost bonding wires enable the saving of precious metal costs, while retaining the performance of pure gold wires in most instances.

Each wire‘s characteristics can get adjusted individually to the specific purpose.

Gold Bonding Wires
- High strength and good loop stability
- High reliability
- Lowest ball hardness

Low Cost Gold Bonding Wires
- Homogeneous loop formation
- Improved reliability compared to conventional AuAg
- Comparable performance with Au wire
- Good electrical properties
- Low ball hardness



Typical bonding wire contact on LED die

EMD-PT

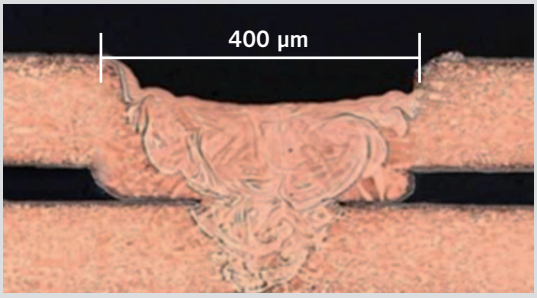
Stamped Circuit Boards (SCB)
Stamped Circuit Board technology is a highly innovative and sophisticated substrate solution for LED packages. It permits the structuring and lamination of metal-plastic combinations in a highly efficient mass production process for millions of parts. During the manufacturing process both the plastic and the metal are initially treated on separate reels and structured according to the specific requirements. No other technology can structure an isolating plastic layer so easy to enable package designs without any isolation material underneath the chip.

Heraeus has entered the stage front with this technology and offers a fully comprehensive concept for thermal management. Basically, it means that heat can be pulled away from the chip quicker and more reliable. Series of tests confirm that the technology is up to par with ceramic boards by lower costs and reel to reel manufacturing possibilities.

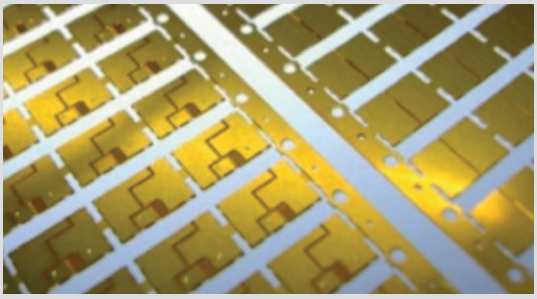
Thermal and Electrical Vias in Multilayer Substrates
- New via technology for reel to reel process
- Imprinted Cu-layer is laser welded to the bottom layer
- Standard via size 0.4 mm
- Proportional size of thermal and electrical pads
- Various electrical conductive layers allow more complex circuits

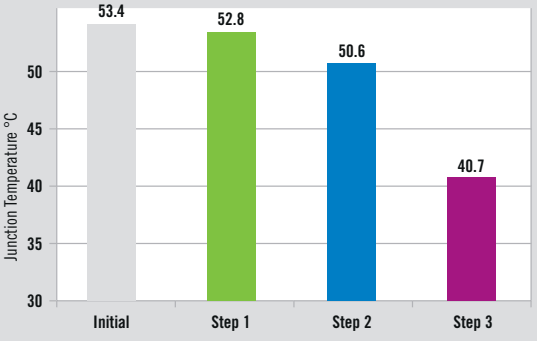
Optimization Possibilities to reduce the Junction Temperature

Parameter	Initial	Step 1	Step 2	Step 3
ω metal (W/mK)	180	380	380	380
Metal thickness (µm)	150	150	500	500
Design	A	A	A	B
Footprint "Heat-Slug" (mm²)	12	12	12	35



400 µm coined and laser welding


Multilayer stripe design



TMD-ELC

The Thin Film Materials Division of Heraeus manufactures state-of-the-art high purity sputtering and evaporation materials for various applications in Electronics, Large Area Coating, and Magnetic Data Storage.

We are a globally competent partner for customer-specific coating solutions due to our comprehensive technological expertise and our global network of development centers, production facilities and sales locations. Owing to our strength in precious metals, Heraeus is ready to support the high volume demands of the LED industry, as well as the specific requirements necessary for good heat dissipation or corrosion resistance of an LED.

Silver alloys, which work as corrosion resistant reflectors in LEDs, are examples of some of the materials used as sputtering targets or slugs. The increasing demand in thermal management is addressed by gold bonding alloys such as AuSn, AuGe and AuAS, which are well proven as dye attach materials, and WTi sputtering materials, used for barriers.

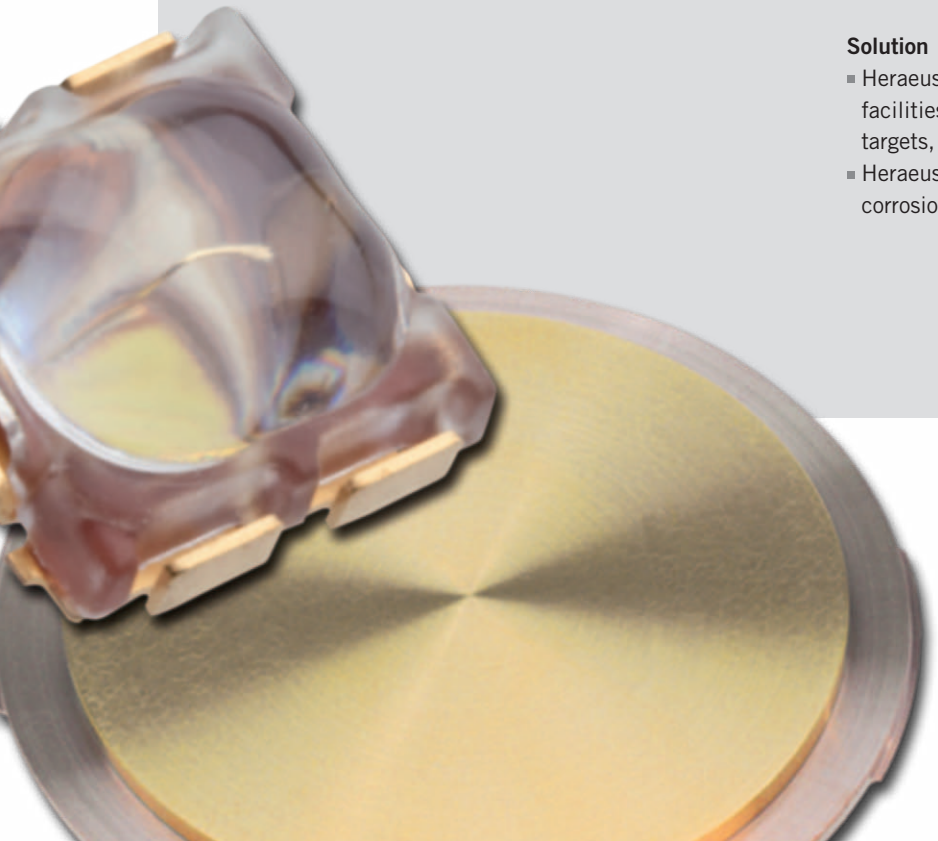
Our customers from the LED industry have come to rely on the material knowledge that Heraeus TMD has gained from supporting the production of electronic components over the last 30 years.

Challenge

- Heat dissipation with optimised layers
- Application of a reflective coating for protection against high temperatures and corrosion

Solution

- Heraeus employs state of the art manufacturing facilities for AuSn, AuGe, Ag, Pt, WTi and Sn targets, as well as for evaporation material
- Heraeus silver alloys demonstrate excellent corrosion protection and a high reflectance



High brightness LED assembly

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