Optical characterization of polymers, design and manufacture of microlenses for LEDs

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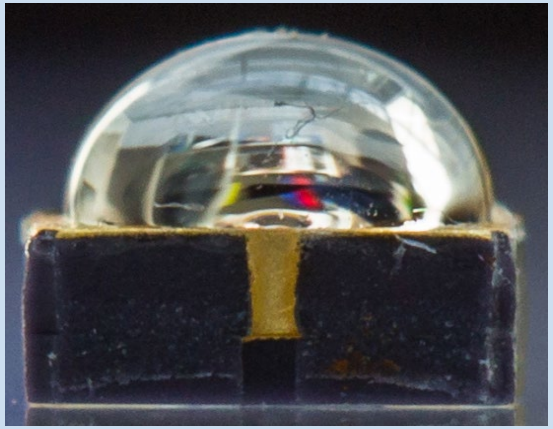

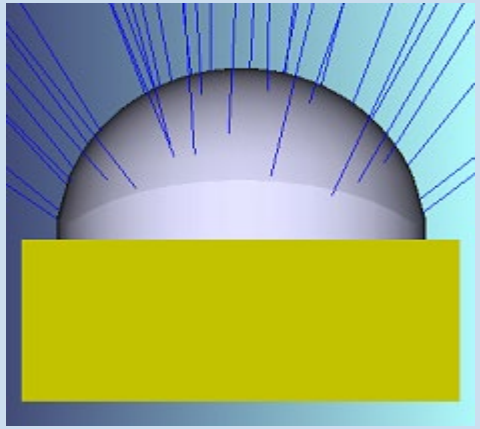

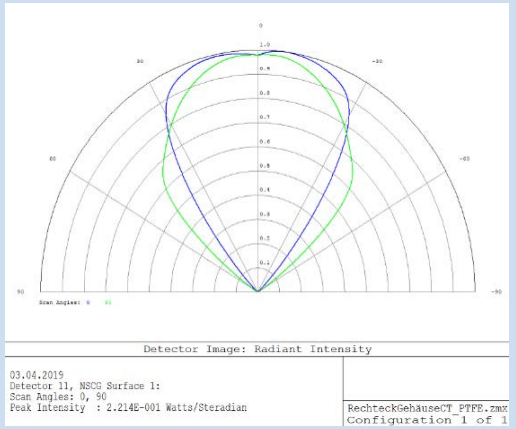

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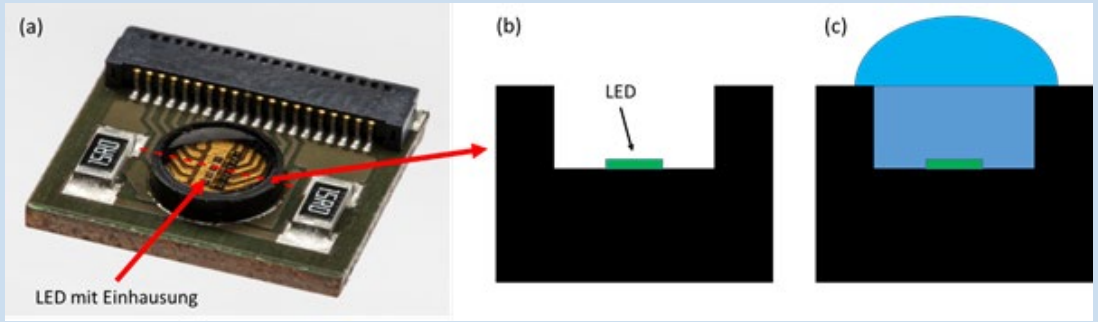
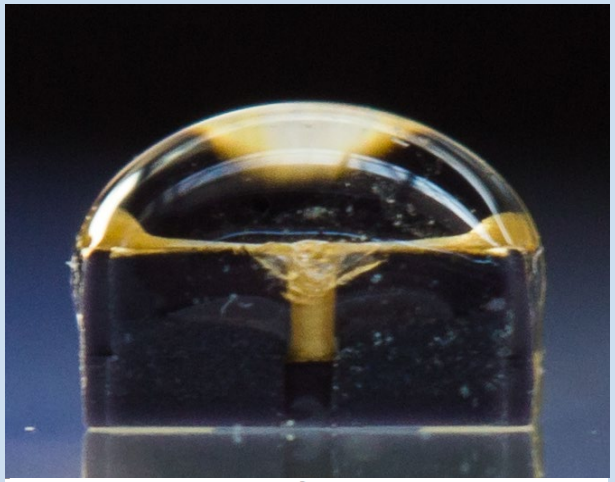
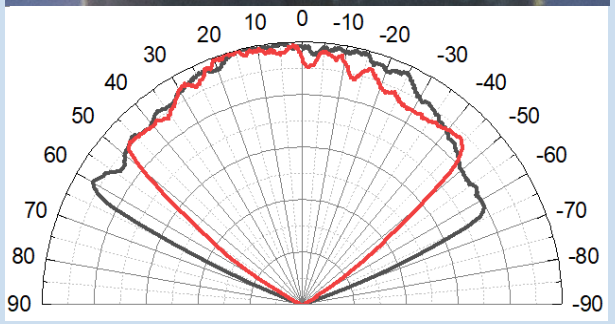
Content

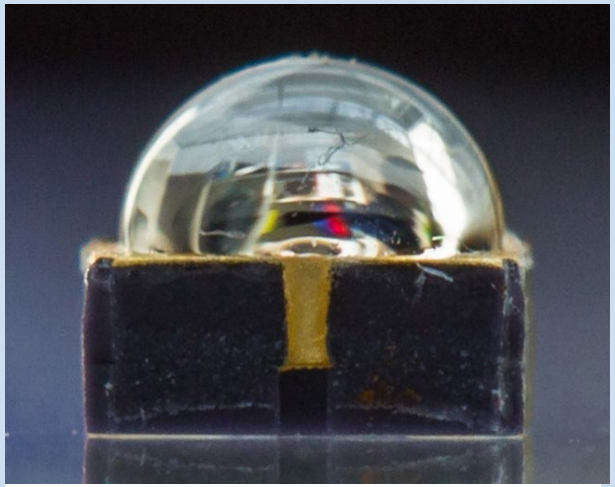
1. Introduction
2. Requirements
3. Polymers
4. Optical properties of the polymers
5. Thermal investigation of the polymers
6. Polymer lenses on LED housing: measurement and simulation
7. Optical design for housing optimization
8. Summary

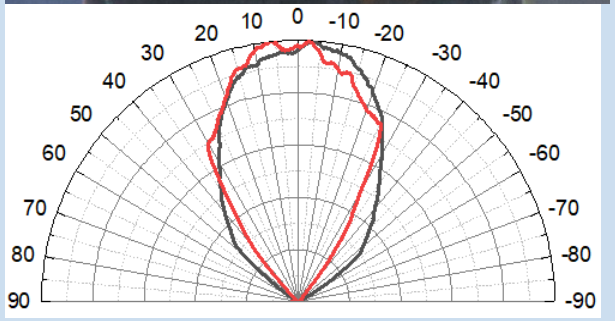
1. Introduction





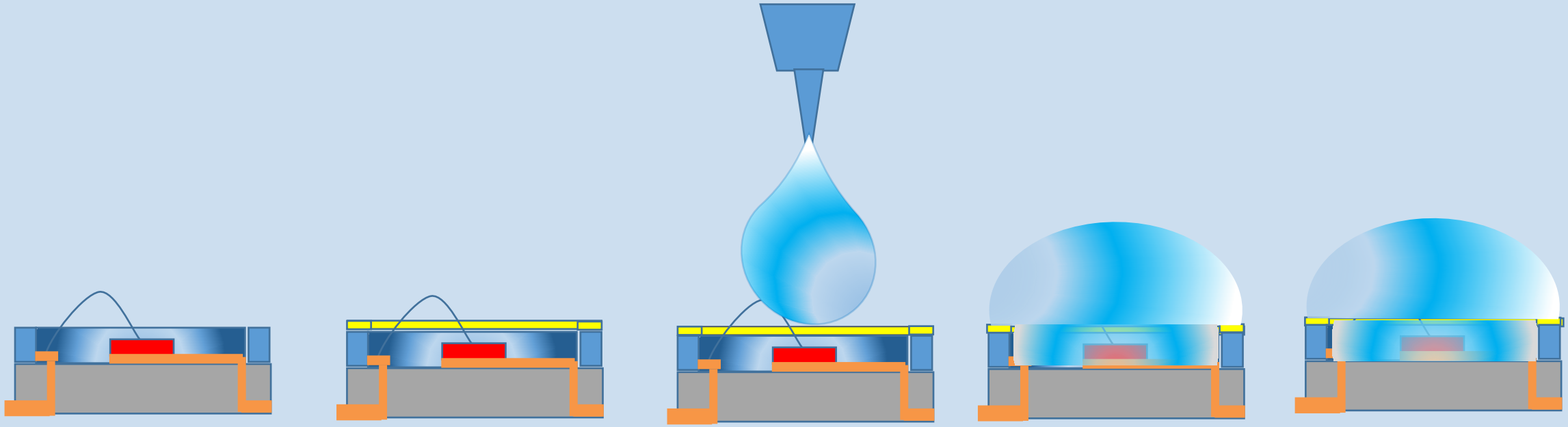






1. Introduction

Manufacturing process



CoB LED with housing

Surface modification for edge angle or focal length adjustment

Polymer Dispensing

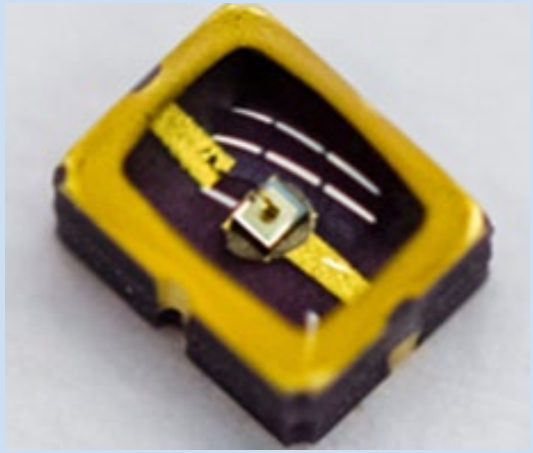
LED lens

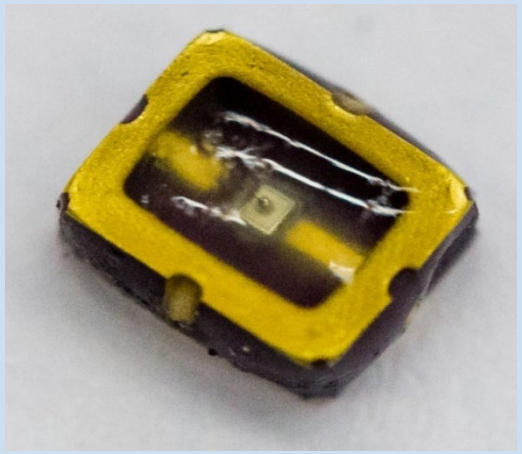
Hardening

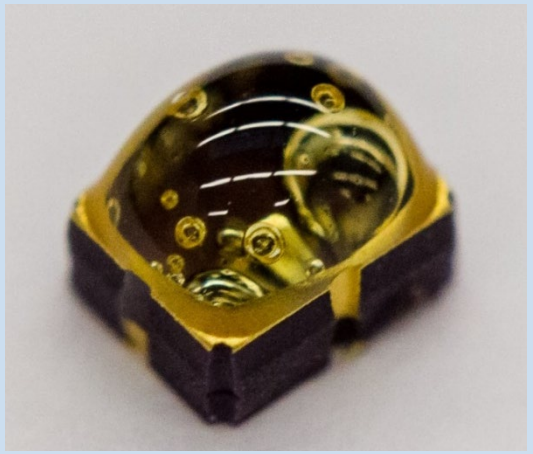
2. Requirements

- High transparency in the spectral range from 400 to 1700nm
- Temperature stability in the range from -40°C to 125°C
- Refractive index approx. 1.5
- Realisation of different lens geometries, optimal would be beam angles between 45° and 90°
- Time and cost-saving manufacturing techniques based on dispensing systems

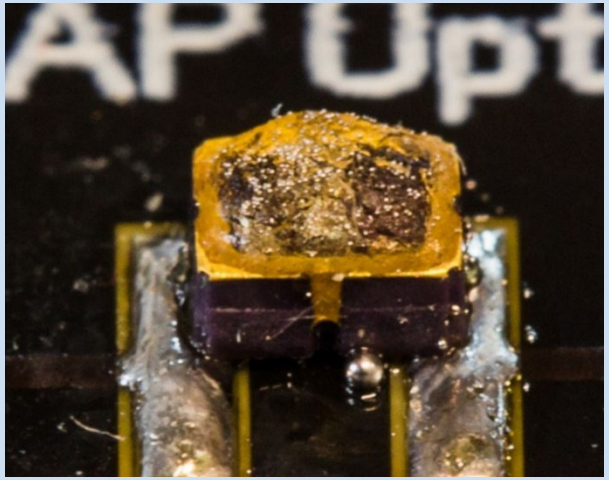
3. Polymers

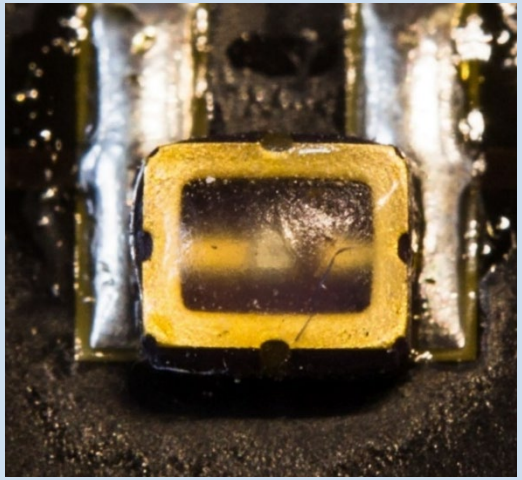


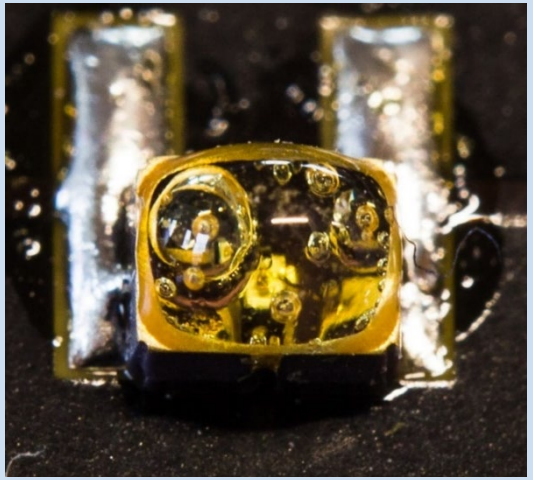




Before soldering







After Soldering

Guronic C-400
(Modified hydrocarbon resin)

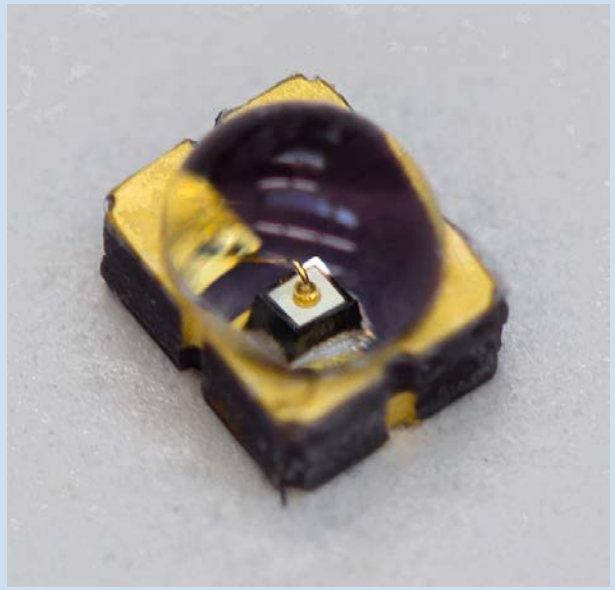
resPUR-OT-T24000

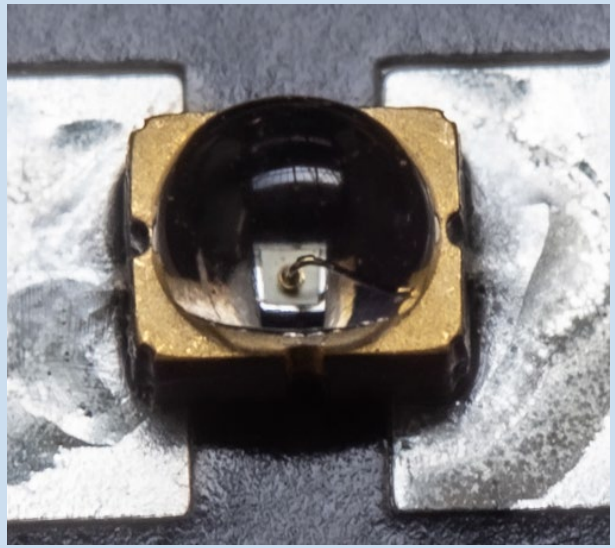
resPUR-OT-3000

(Two-component polyurethane)

3. Polymers

Optimized polyurethane resPUR-OT



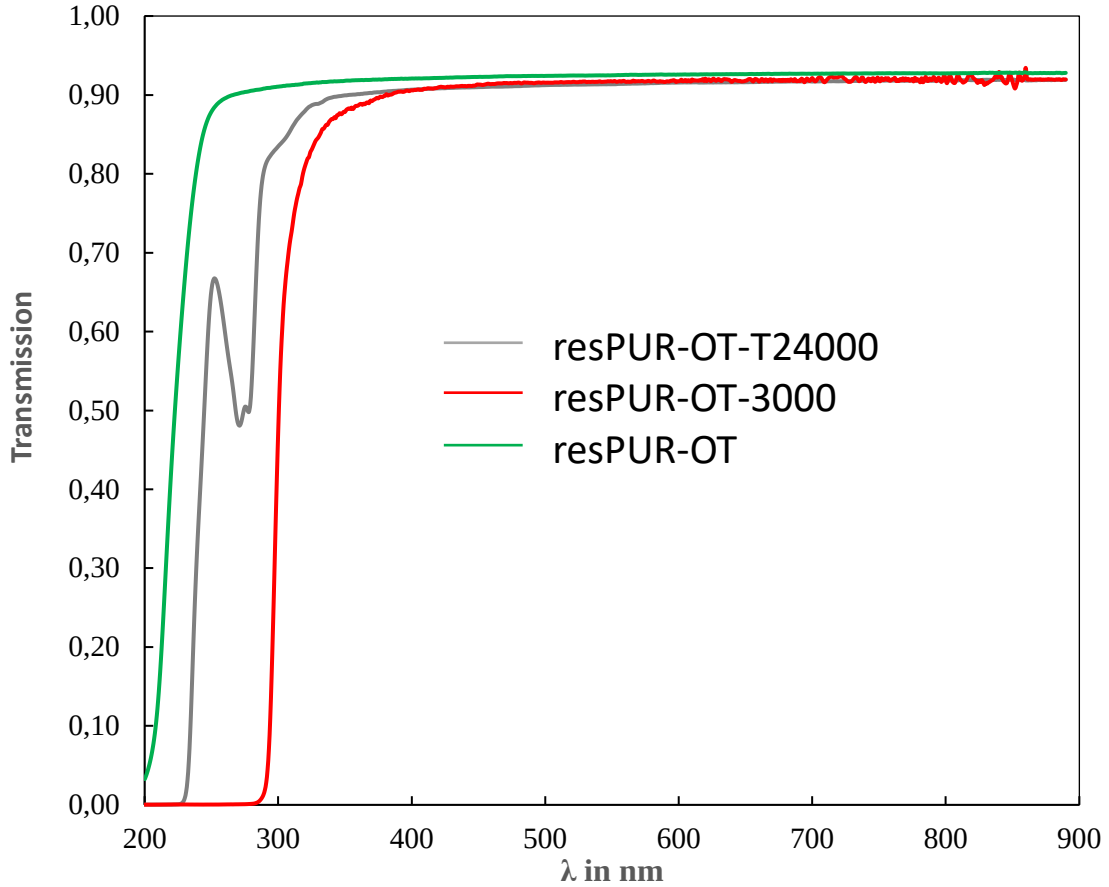


resPUR-OT:

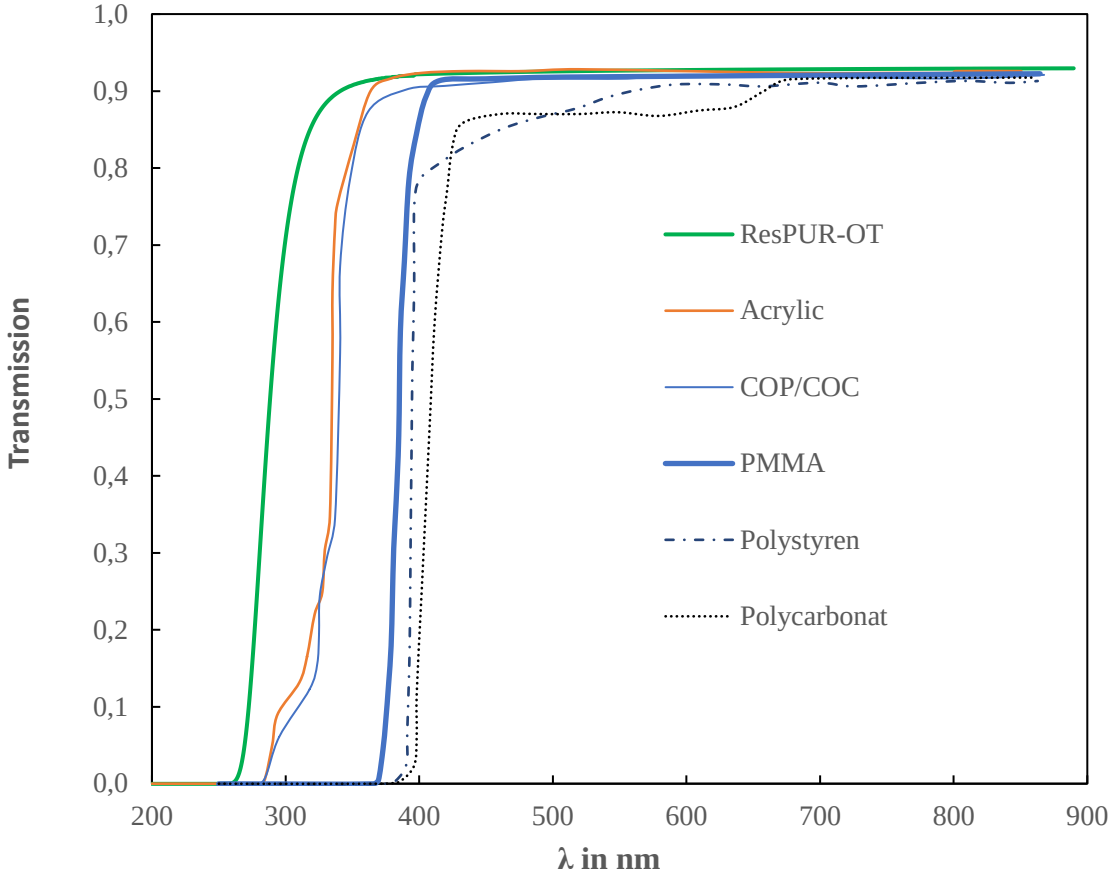
- Very transparent
- Very hard compared to the other polymers
- Pot life approx. 24h
- Curing time at 120°C: approx. 2h
- No problems with bubbles
- Thermally very stable compared to the other polymers
- Low viscosity
- Very high surface tension (contact angle on PTFE: 90°)

4. Optical properties of the polymers

Transmission of the polymers



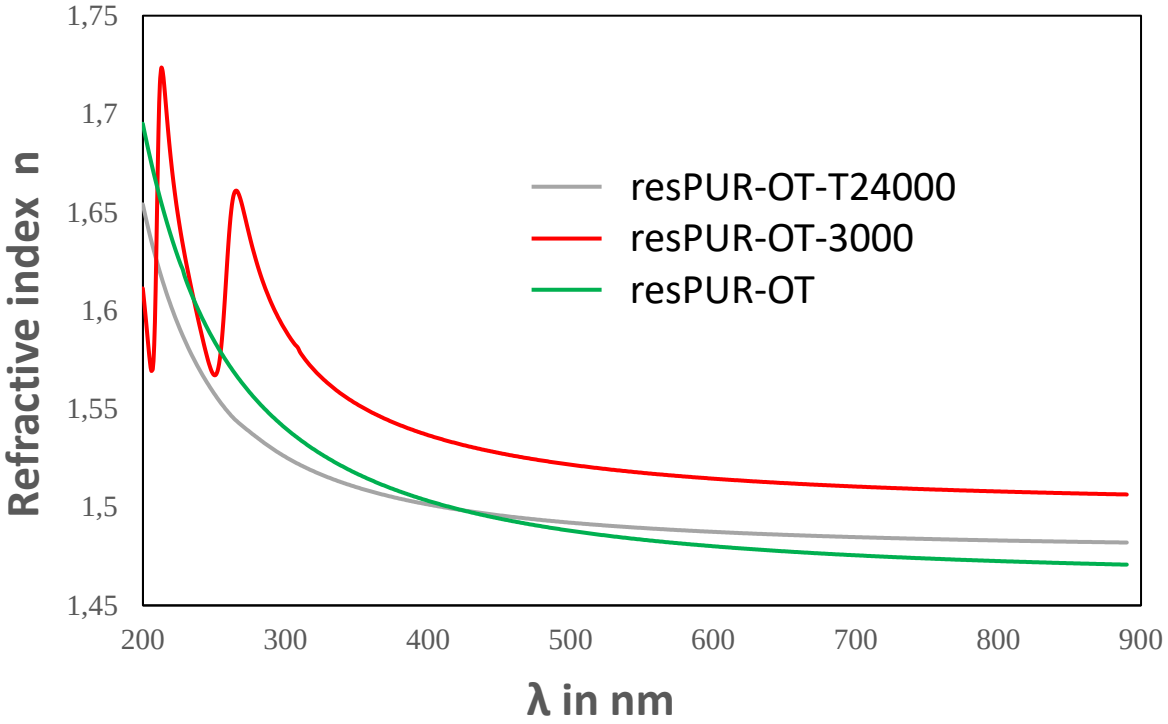
Polymers with 5-15µm layer thickness on quartz

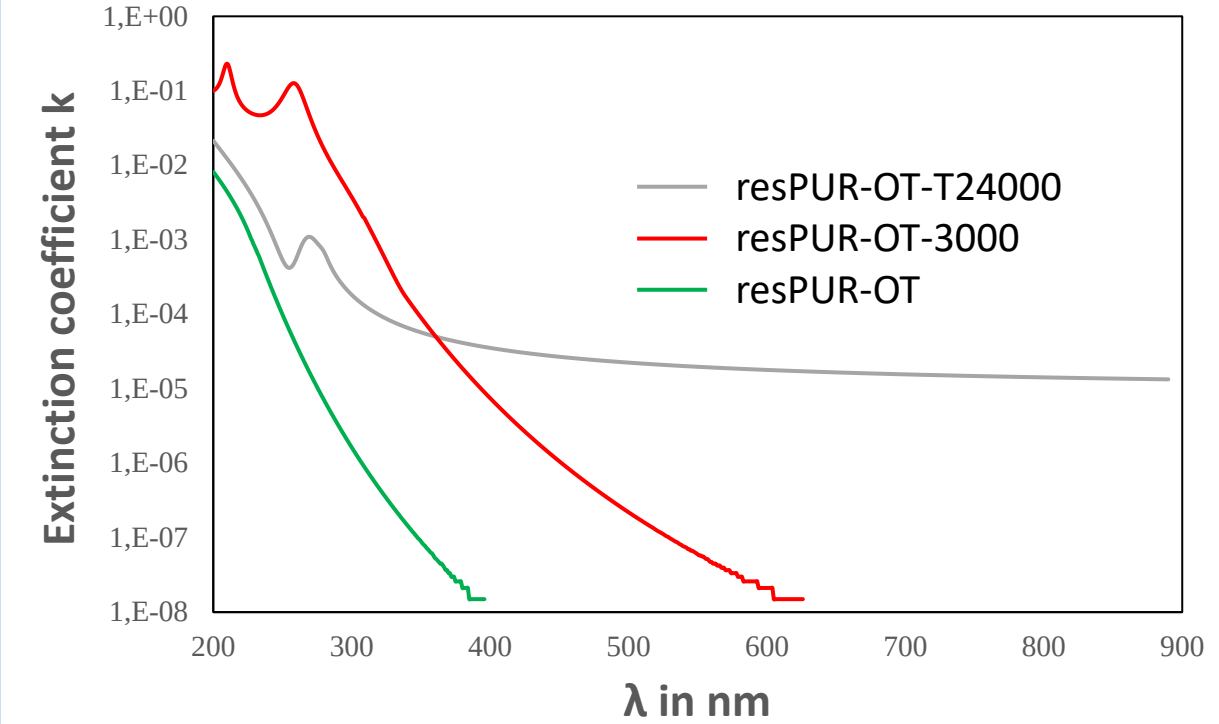


resPUR-OT compared to other optical polymers thickness from 3mm

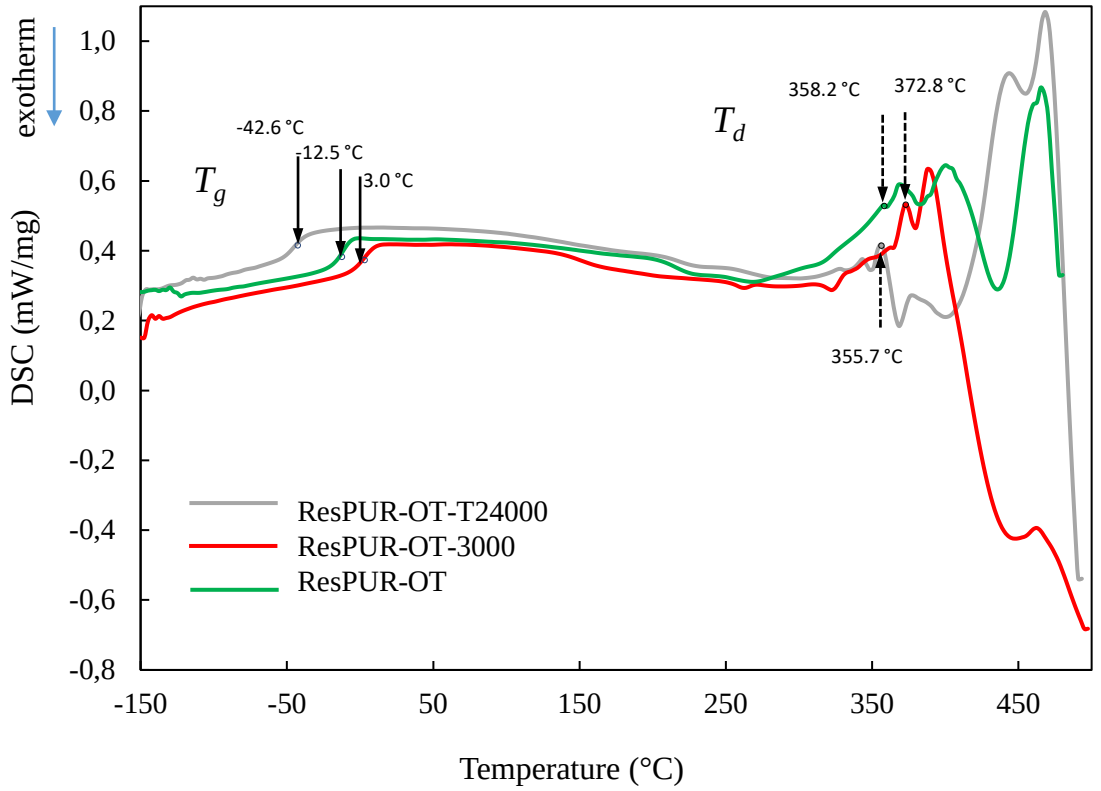
4. Optical properties of the polymers

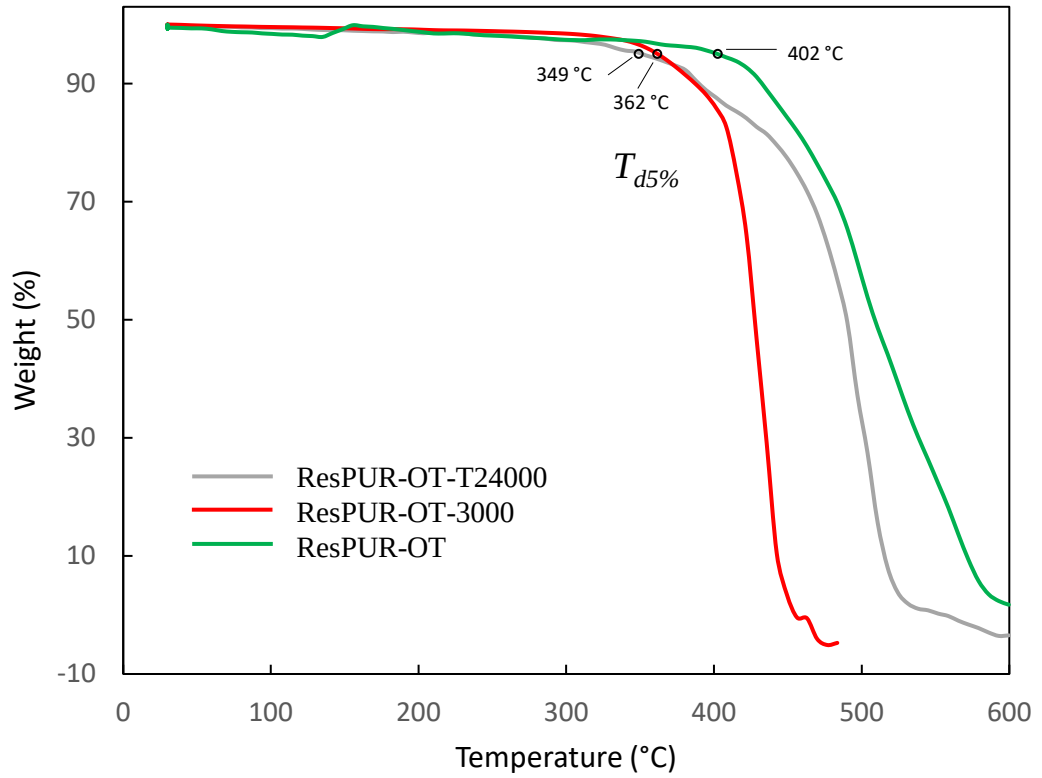
Refractive index n and extinction coefficient k





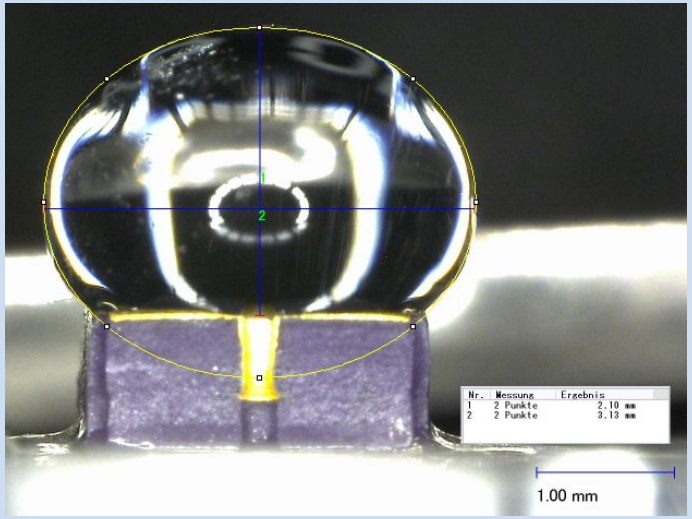
5. Thermal investigation of the polymers

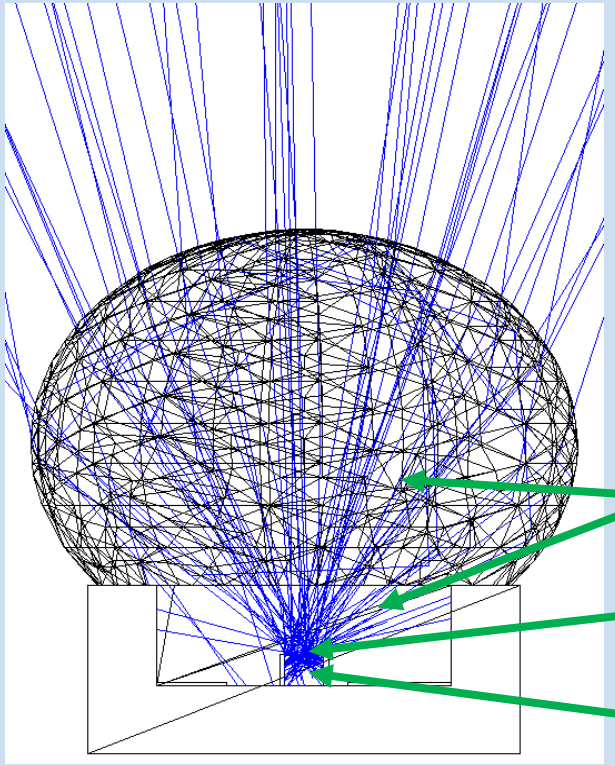




6. Polymer lenses on LED housing: measurement and simulation

Simulation with Zemax





Reconstruction of the polymer lens with
Toric lens or ellipsoid

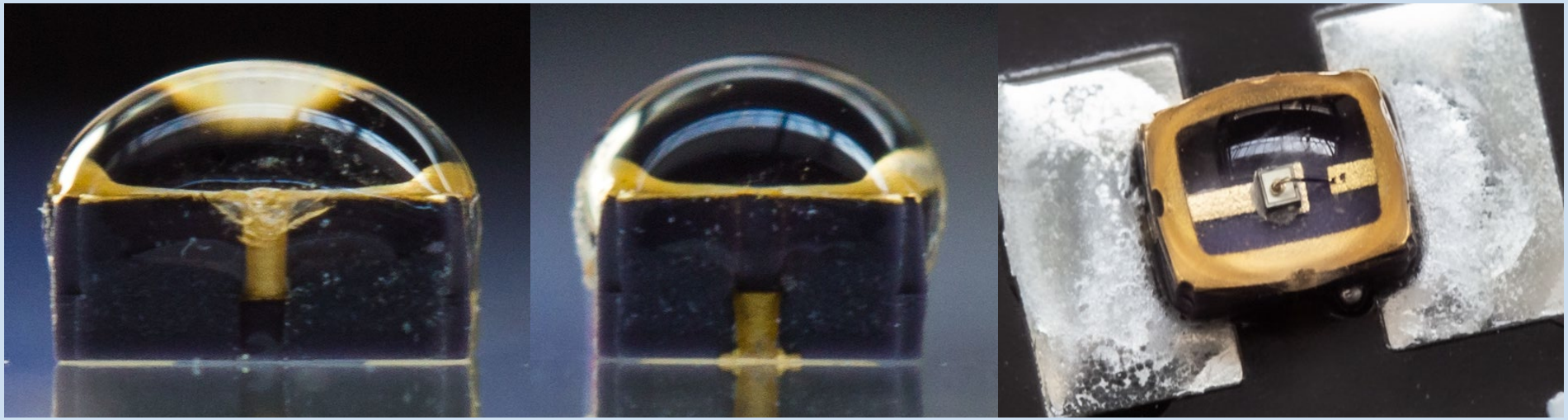
Polymer n=1,5

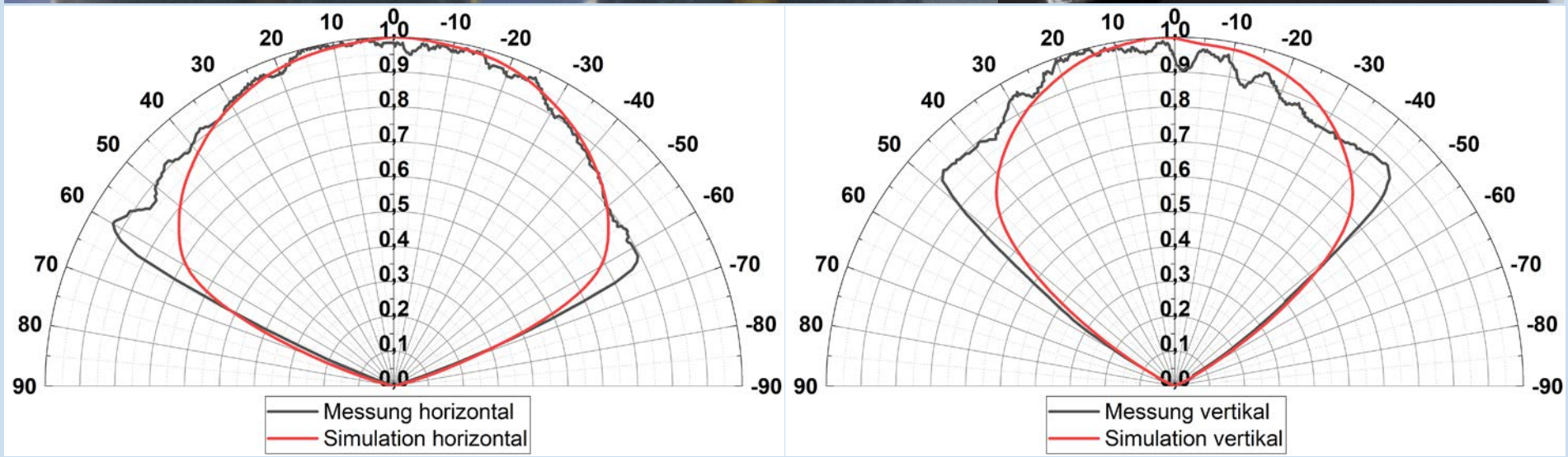
Beam source (pn junction) with
Lambert distribution 10µm below chip surface

Chip InGaN, n=2,3 bei 525 nm

6. Polymer lenses on LED housing: measurement and simulation

resPUR-OT on untreated housing surface

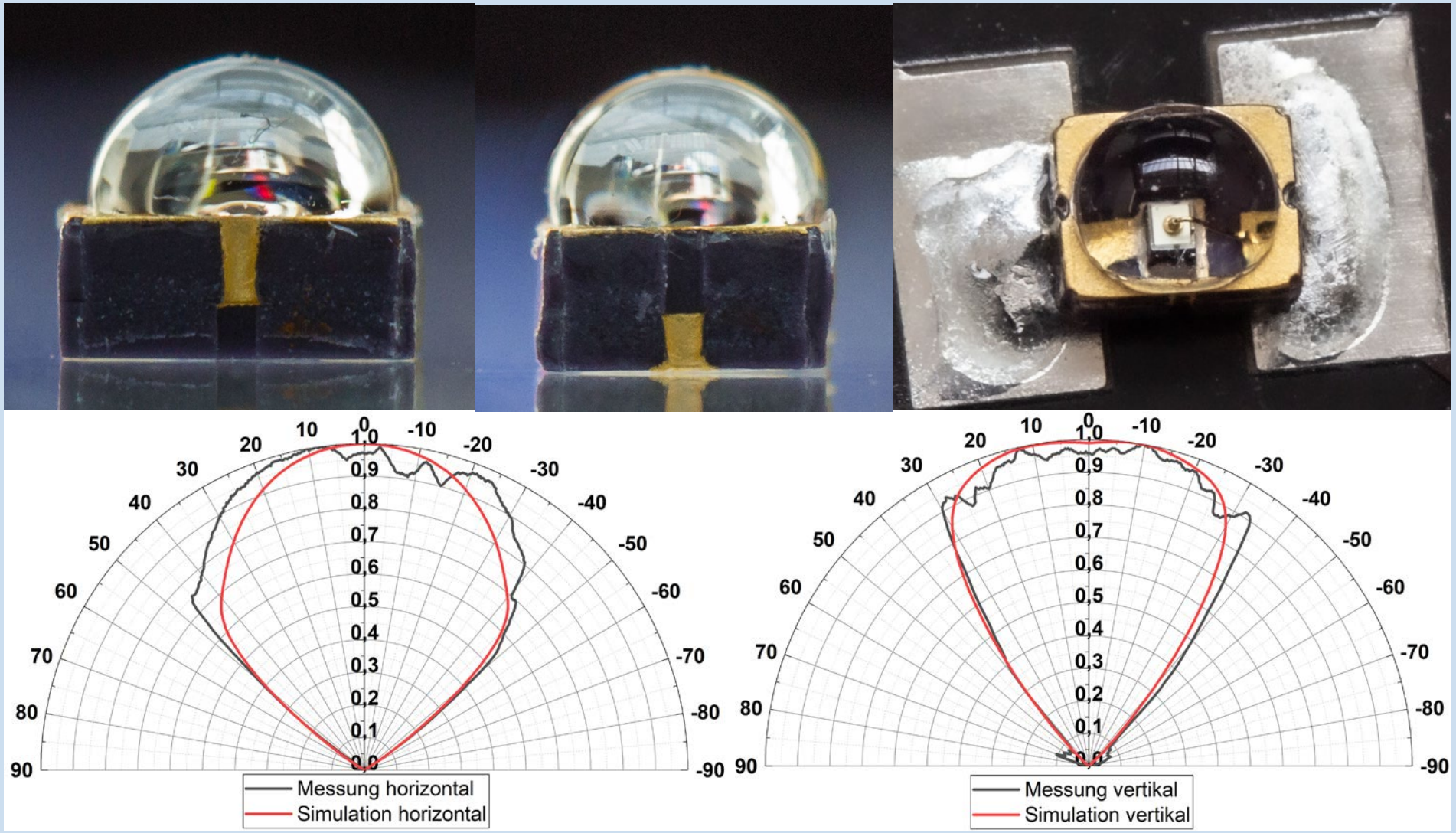




Measured beam angle:
132° / 104°

6. Polymer lenses on LED housing: measurement and simulation

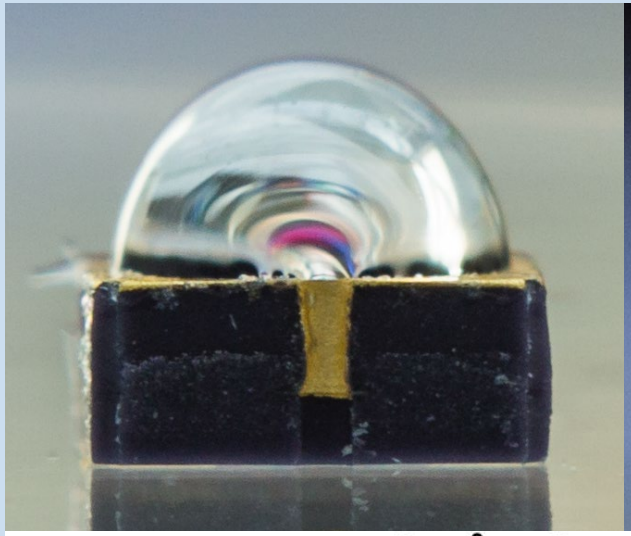
resPUR-OT on PTFE

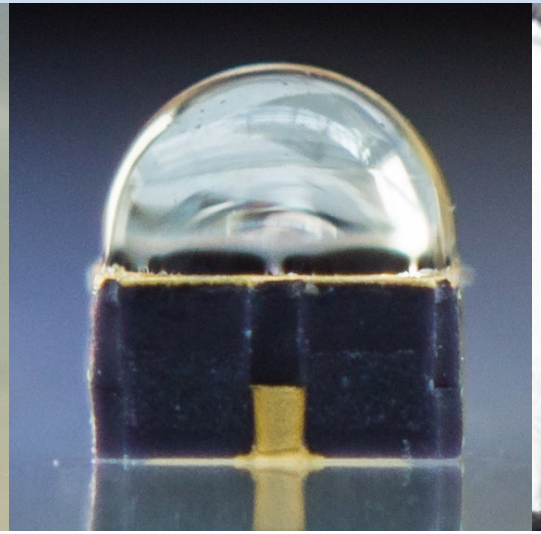


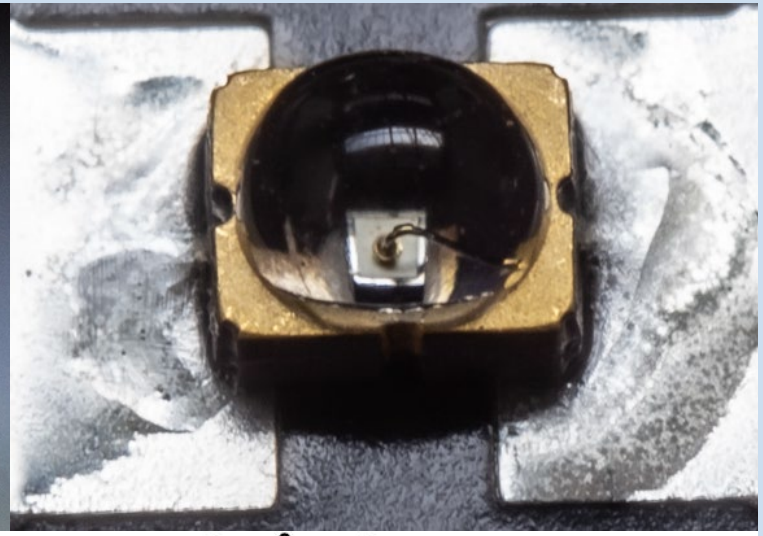
Measured beam angle:
100° / 75°

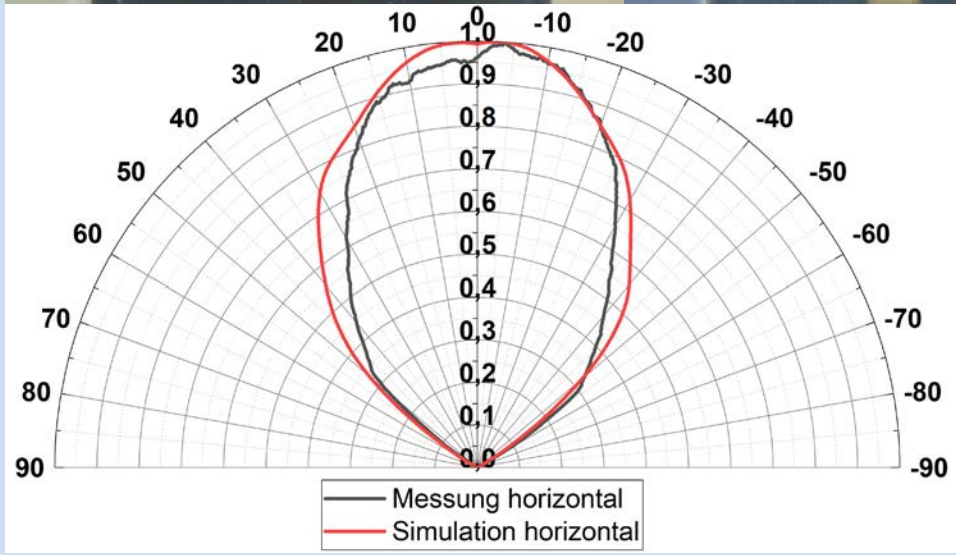
6. Polymer lenses on LED housing: measurement and simulation

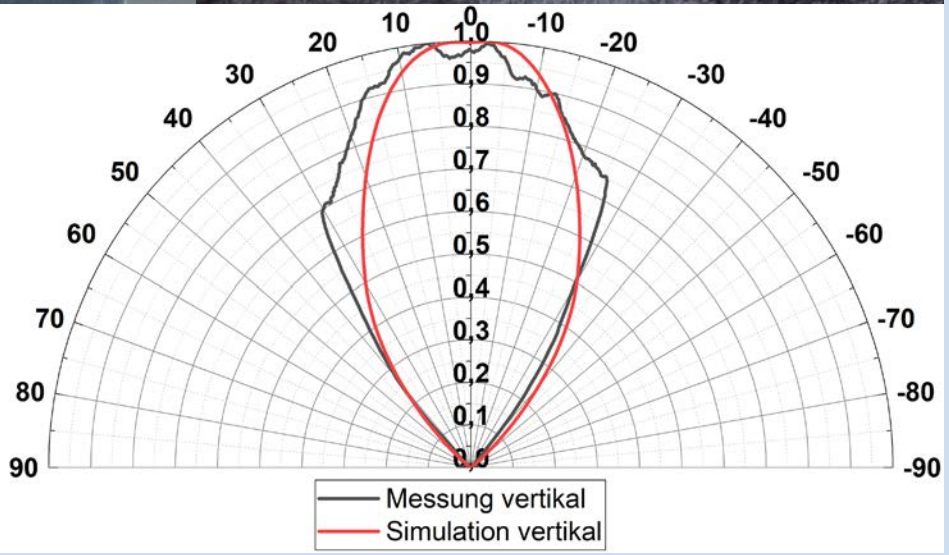
resPUR-OT on PTFE hardened hanging







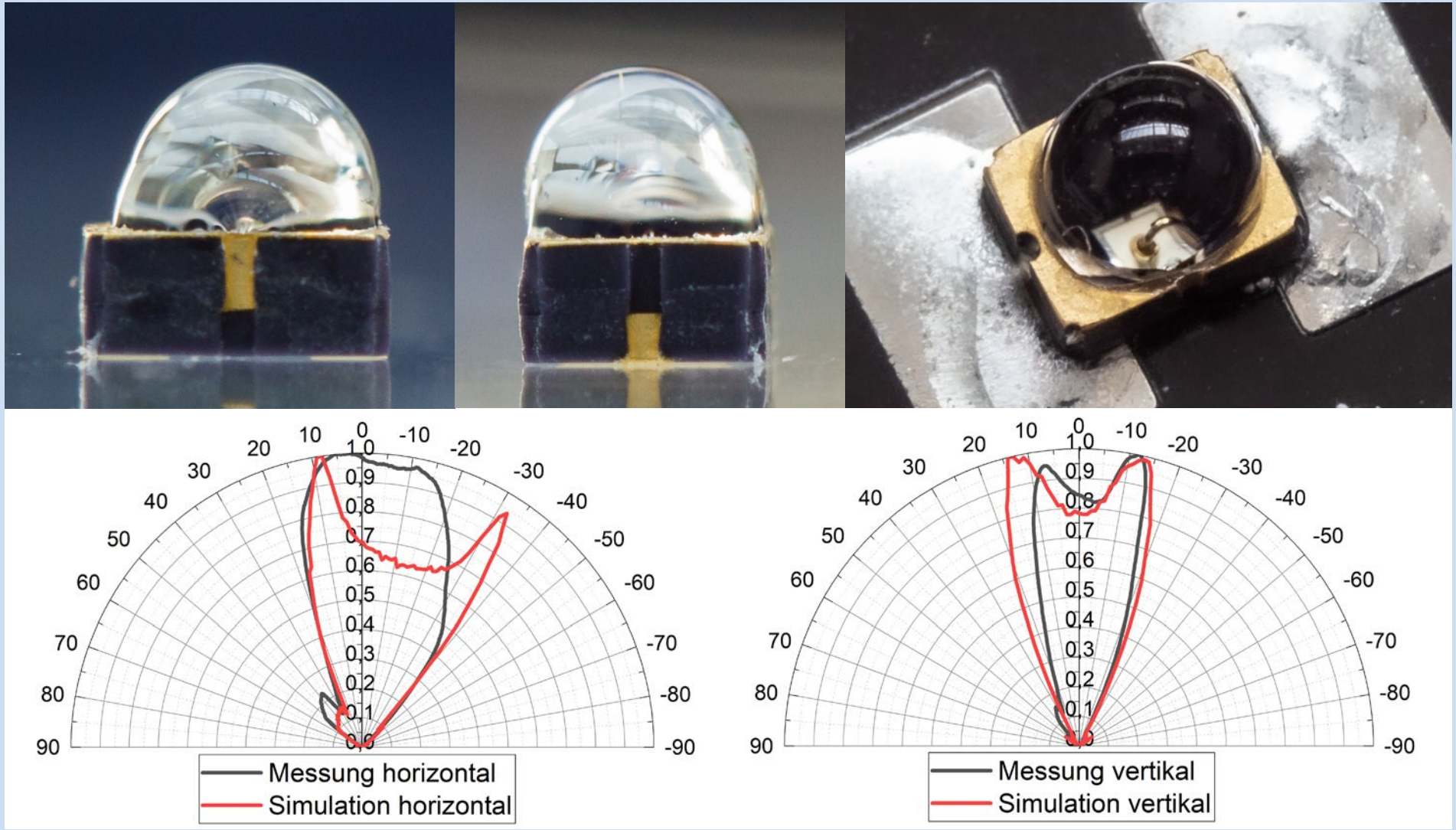




Measured beam angle:
75° / 65°

6. Polymer lenses on LED housing: measurement and simulation

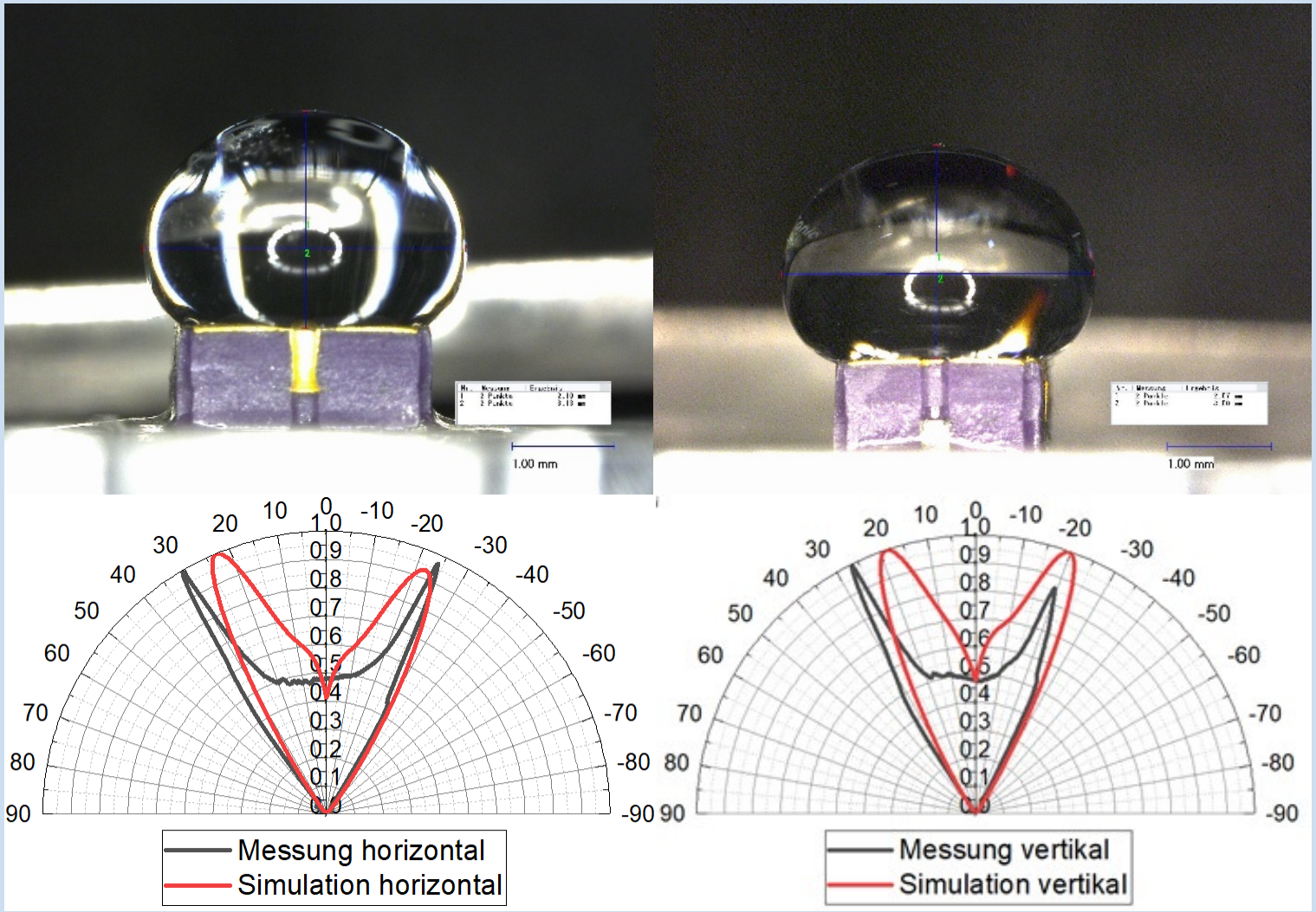
resPUR-OT –Dome lens



Measured beam angle:
53° / 35°

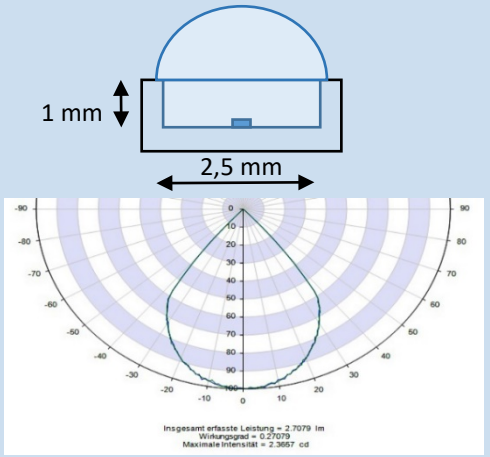
6. Polymer lenses on LED housing: measurement and simulation

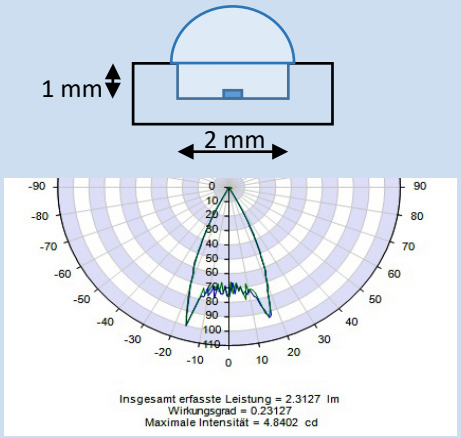
resPUR-OT spherical lens

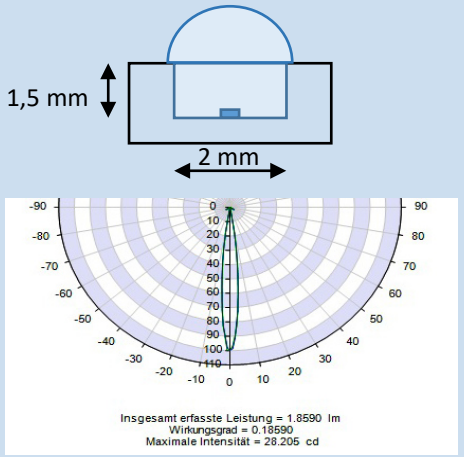


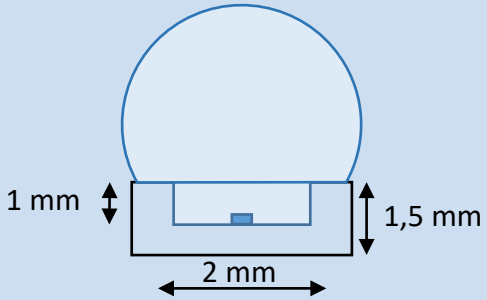
Gemessene Abstrahlwinkel:
63° / 57°

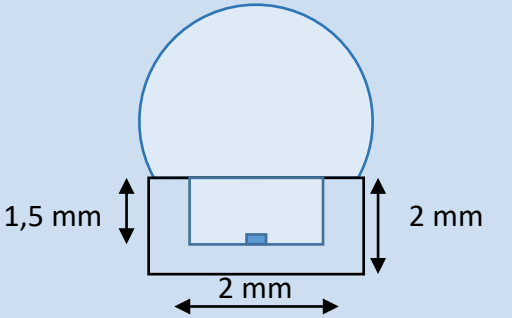
7. Optics design for housing optimisation

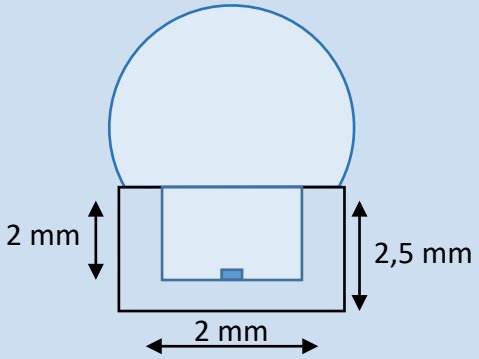




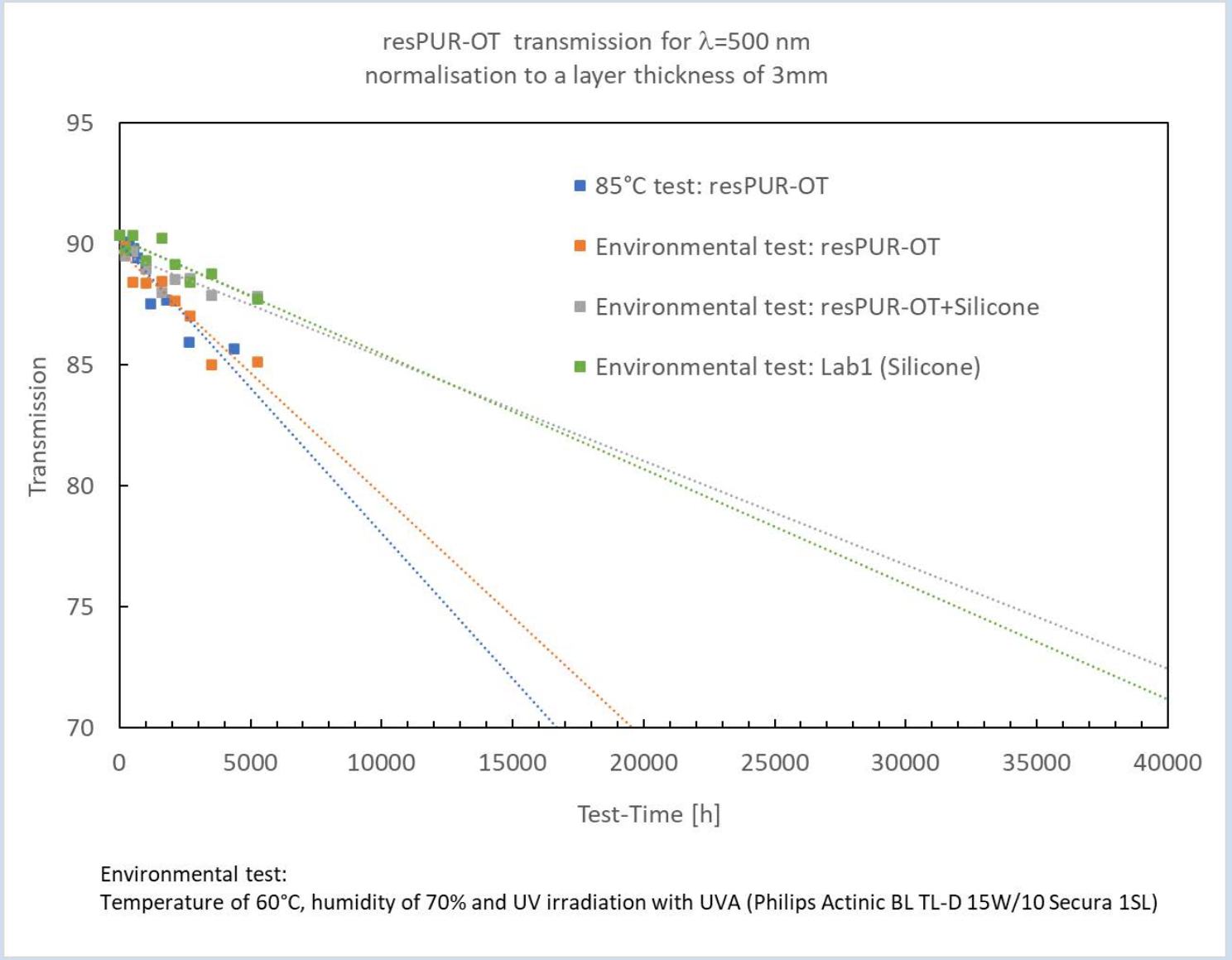






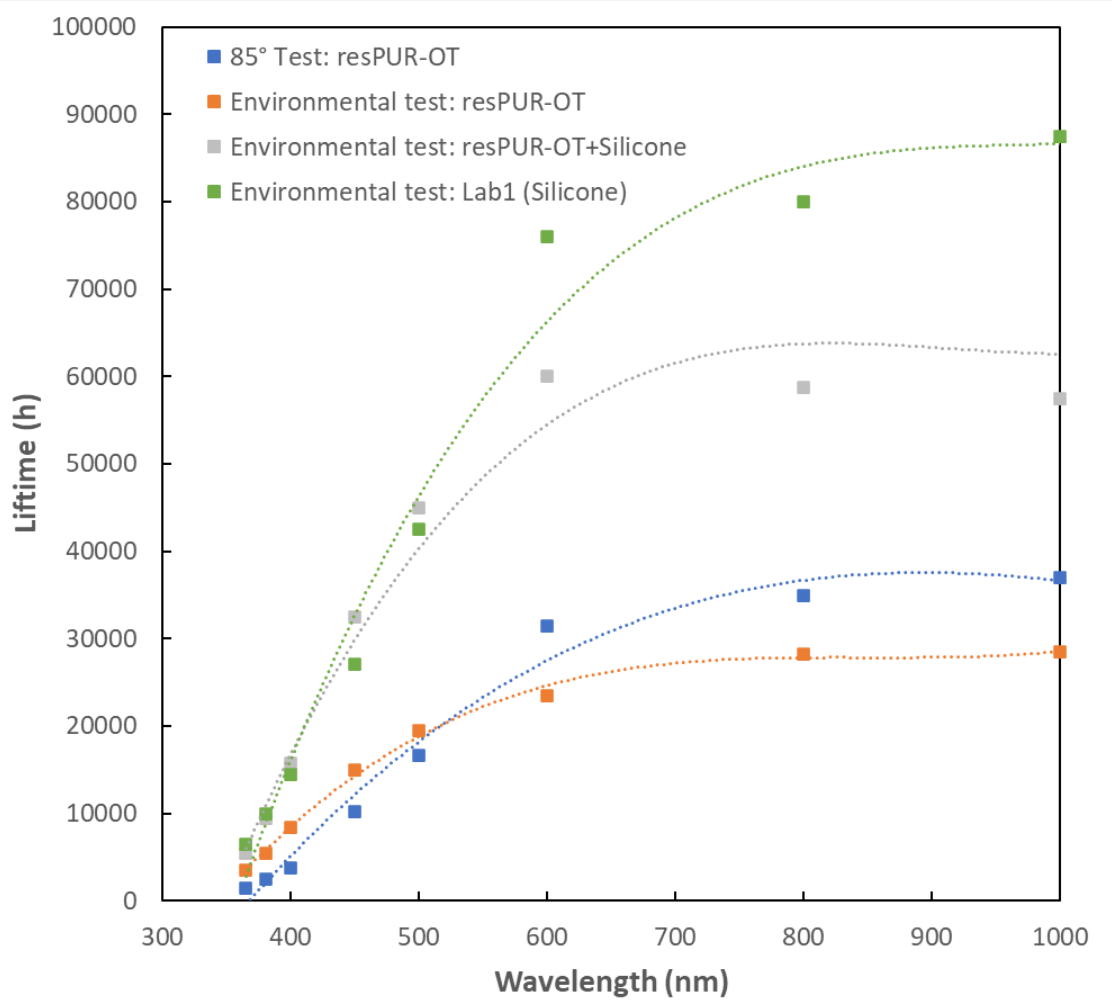


8. Long-term stability



Environmental test:
Temperature of 60°C, humidity of 70% and UV irradiation with UVA (Philips Actinic BL TL-D 15W/10 Secura 1SL)

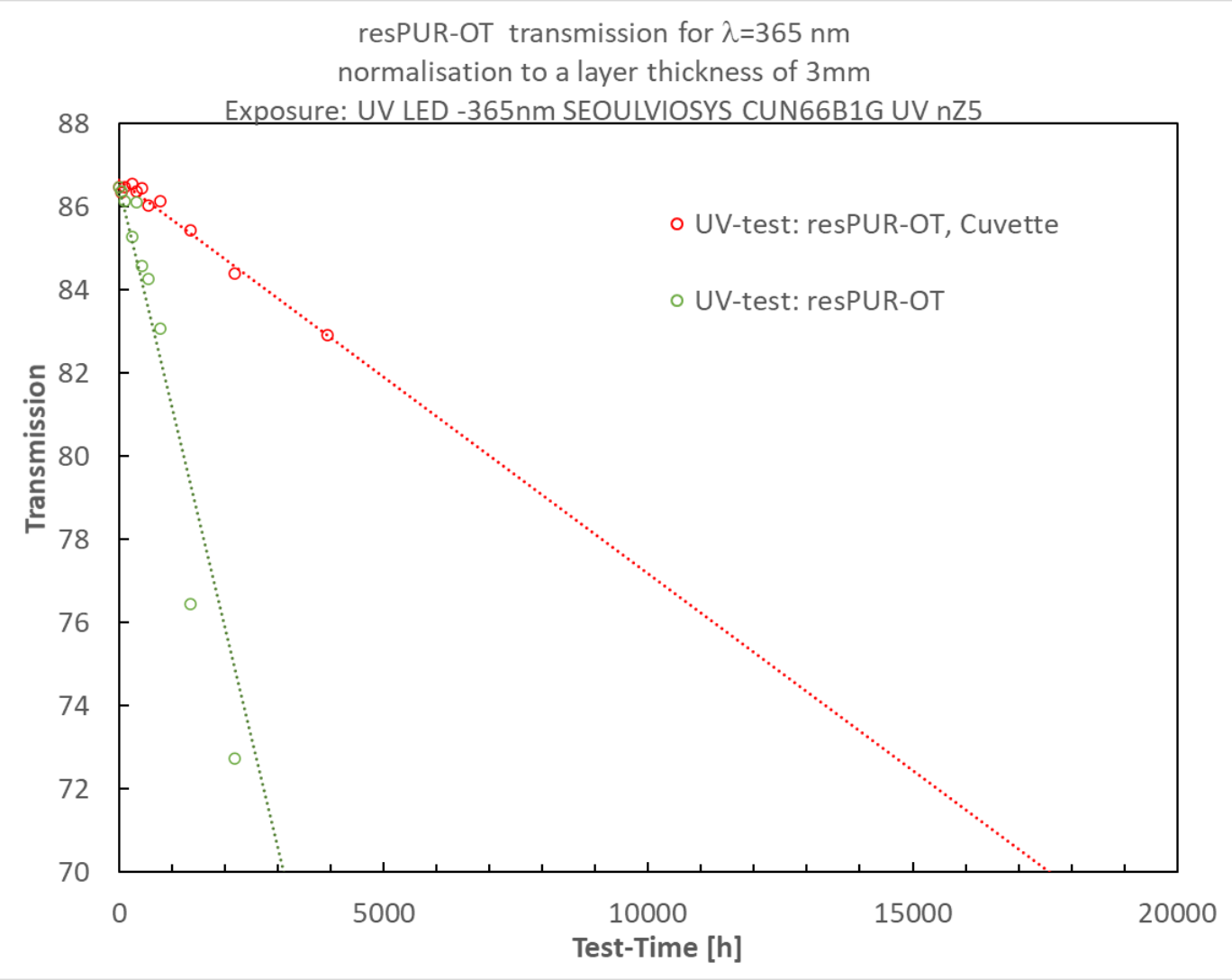
8. Long-term stability



Environmental test:
Temperature of 60°C, humidity of 70% and UV irradiation with UVA (Philips Actinic BL TL-D 15W/10 Secura 1SL)

8. Long-term stability

UV stability



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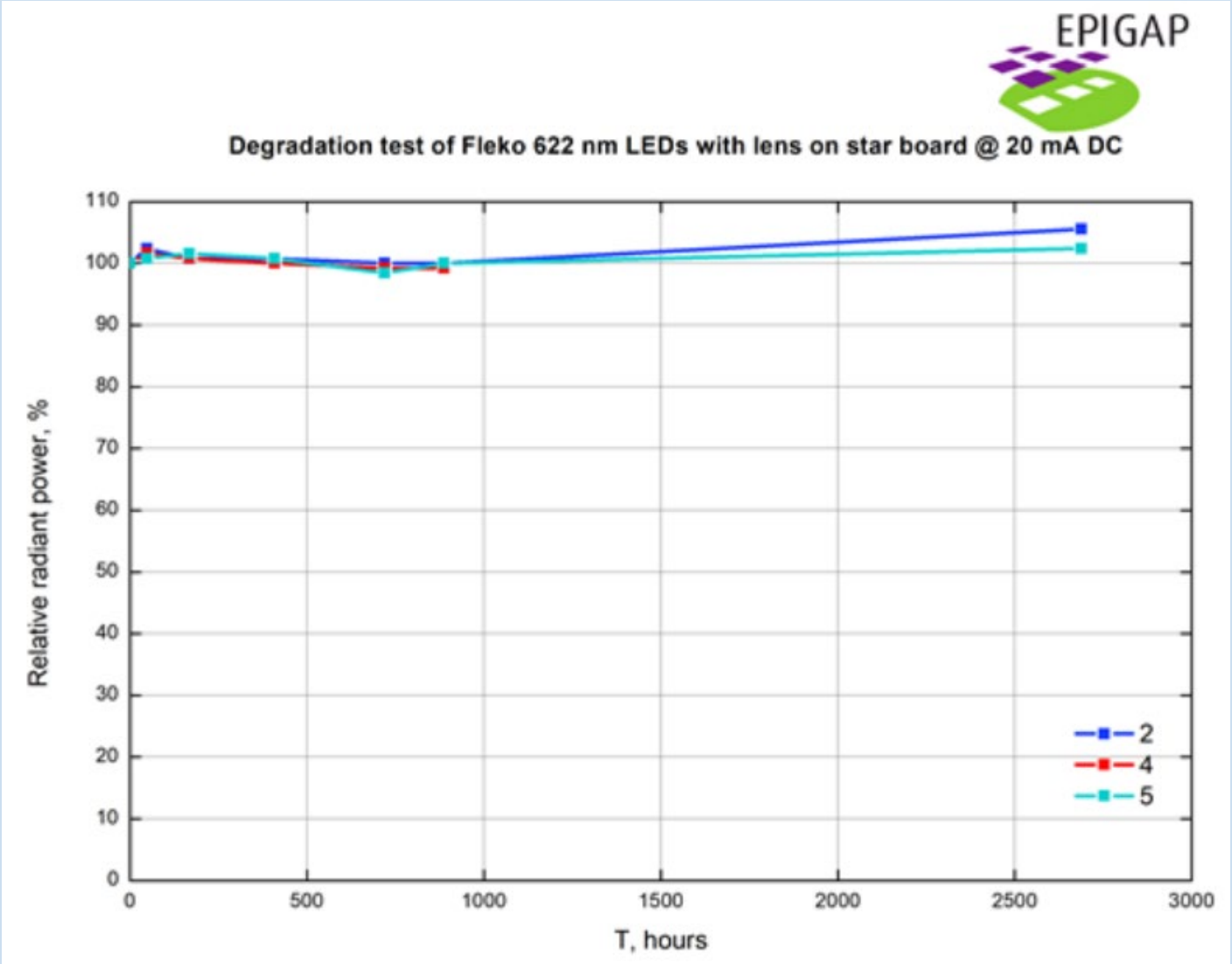

8. Summary

- The optimized polyurethane resPUR-OT has excellent transparency, thermal stability and high surface tension
- Lens shaping by changing the surface tension of the housing surface was successful
- The simulations of the CoB LEDs with Zemax and LightTools agree well with the measurements
- For λ <450nm short lifetime due to environmental influences
- By blocking the oxygen, the lifetimes can be increased

Thank you for your attention