Novel UV-transparent 2-component polyurethane resins for Chip-on-Board LED micro lenses

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Abstract

An optical high-performance plastic based on polyurethane elastomer (PU) was developed, which combines excellent UV transparency with high thermal stability, good hardness, high surface tension and a long pot life. The material is well suitable for microlens applications for Chip-on-Board (CoB) LED technology.

Goal

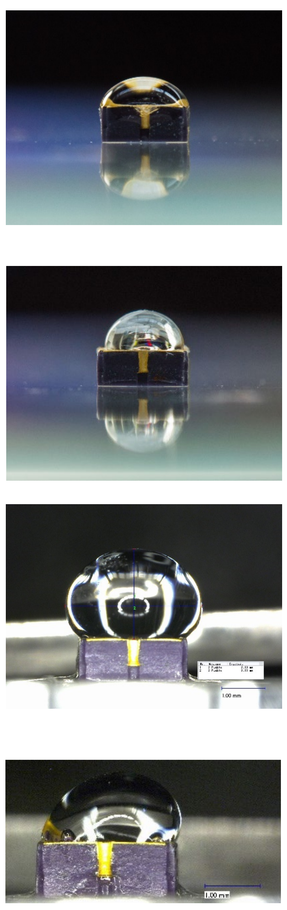
Lighting optics with micro lenses and LEDs must be manufactured in a particularly cost-effective and flexible manner. The major challenge is to achieve excellent transparency, high temperature stability, good mechanical strength and long-term stability of the polymers.

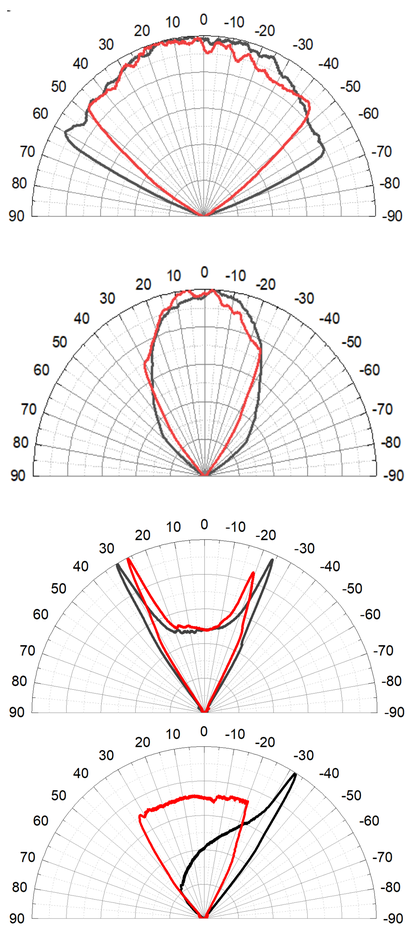
PU material and component specification

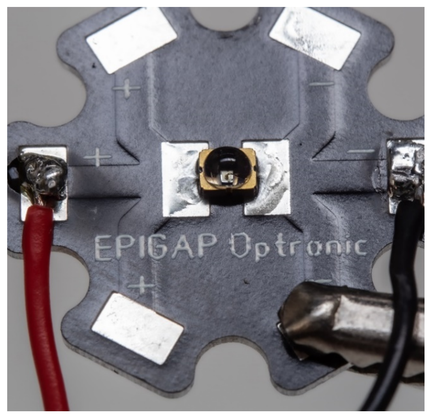
Polyurethane resPUR	OT-3000	OT-T24000	OT
A-component	Polyester polyol		
Polyol OH contend [mg KOH/g]	> 130	> 50	> 130
B-component	P-MDI**	HDI*	HDI*

*Aliphatic isocyanate hexamethylene diisocyanate oligomer (HDI)
**Aromatic methylenediphenyl diisocyanate polymers (P-MDI)

Packaging and lens forming

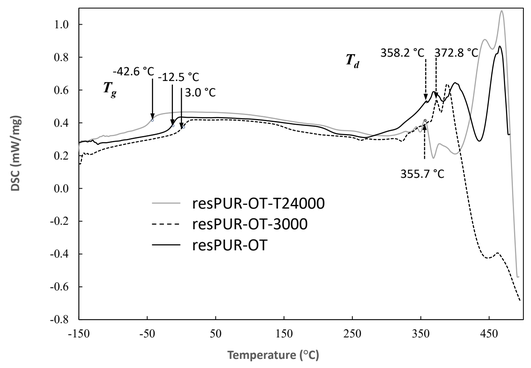




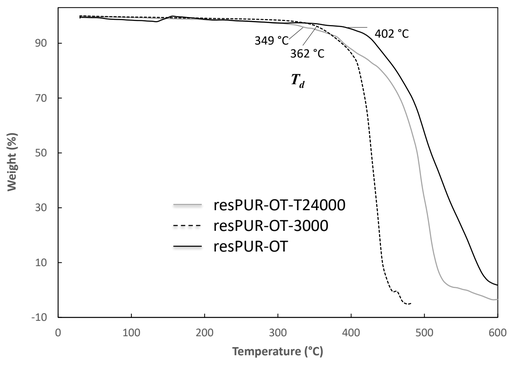


Fabrication results package of InGaN-CoB-LED with resPUR-OT at different surface tensions and corresponding light distributions at λ = 525 nm. The lower lens was tilted during hardening. [2][5]

Thermal properties

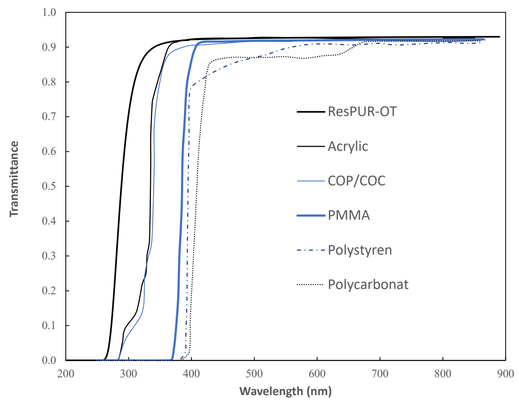


Differential scanning calorimetry (DSC) measurements at temperatures from -150 to 500 °C. The points indicate the glass transition temperatures T_g and the degradation temperatures T_d of the PU. Secondary reactions of the isocyanates are shown in the range from 150 to 220 °C.[4,6]

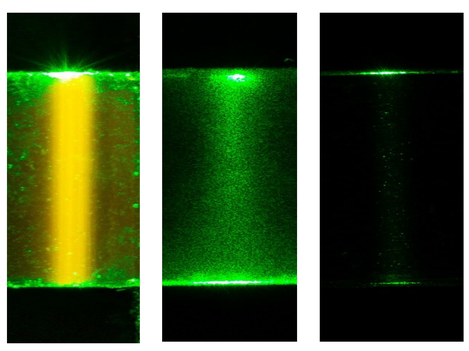


Thermogravimetry (TGA) curve of the polyurethane. Temperature program: Heat from 20 °C to 600 °C with heating rate of 10 °C/min, in nitrogen atmosphere with a purge rate of 10 mL/minute. Marked are the 5 % weight loss temperatures. [4,6]

Optical properties



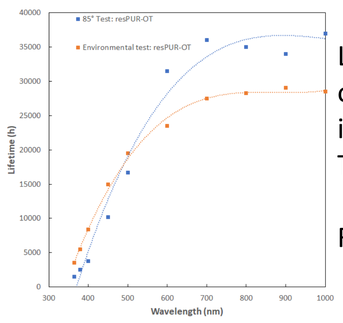
Transmittance of optical polymers [1] at a film of 3.174 µm compared to resPUR-OT .



a) b) c)

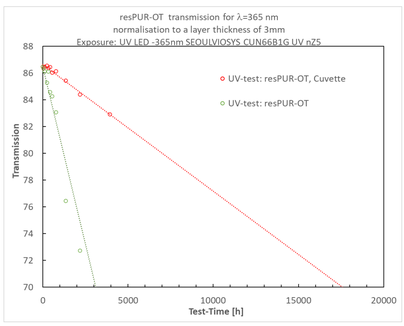
Laser scattering properties:
a) resPUR-OT-3000 material, shows fluorescence and has a scattering coefficient of $k_s = 5.1E^{-6}$,
b) resPUR-OT-T24000, $k_s = 7.5E^{-6}$
c) resPUR-OT, $k_s = 3.9E^{-7}$
The scattering coefficient k_s was determinded by using Lambert-Beer's law.

Long-term stability



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

Right: UV-Test at 365nm



Summary:

- This optimized material (resPUR-OT) has an excellent transparency, high thermal stability up to 344 °C and provides the possibility of a simple and cost-effective dispensing technique to ensure a stable encapsulation of LEDs with the possibility of lens formation [2, 3].
- The optical properties and the parameters of the band structure of PU can be changed in a wide range by the mixing ratio of the material components.
- The method presented here turns out to be a useful approach for the development of optical materials. The result confirms that highly transparent PU can be produced from aliphatic isocyanates and polyester polyol with optimized mixing ratios. [4,6]

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