



YEK GLASS Co., Ltd.

YEK Glass is committed to helping take on even the **toughest challenges in glass**

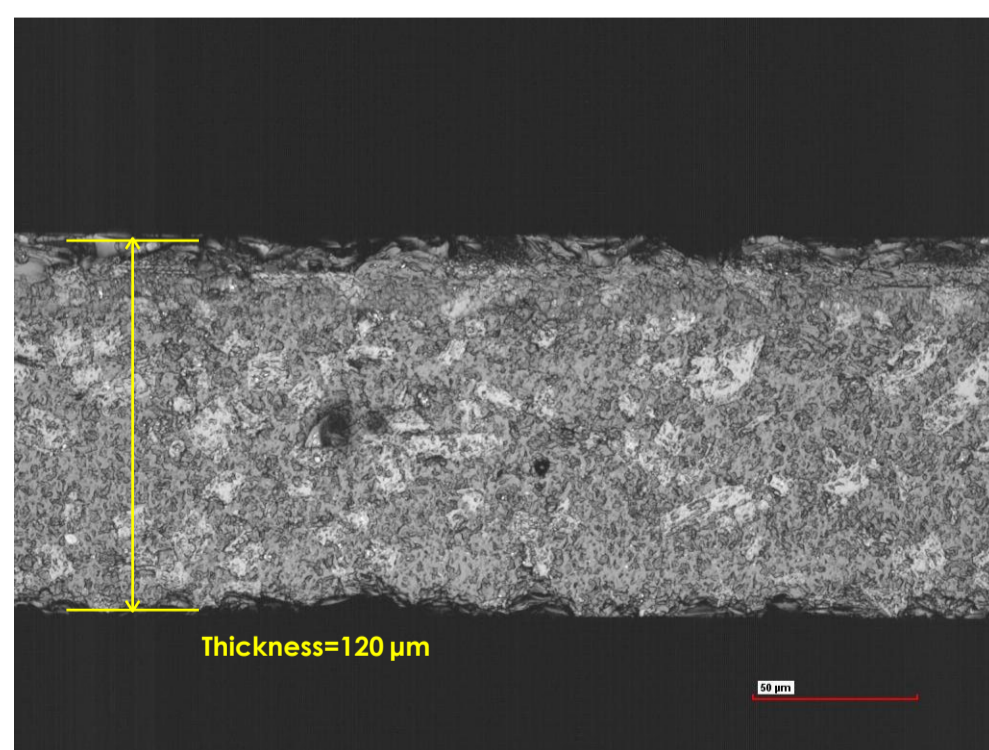
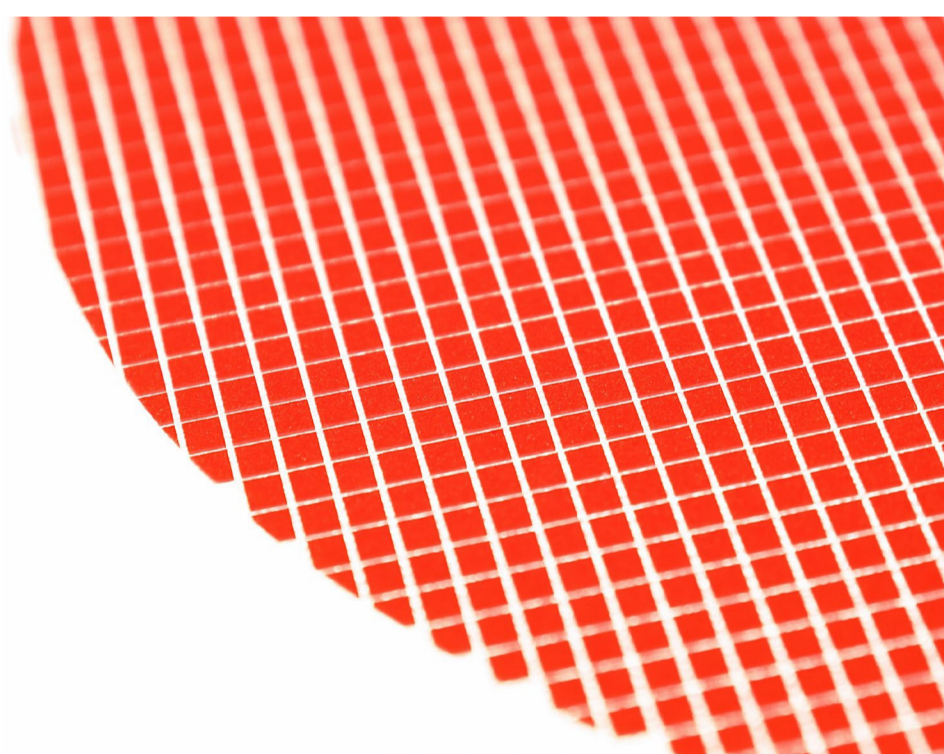
Phosphor-in-Glass
For LED Packaging

PRODUCT INFORMATION

Phosphor in Glass (PiG) was developed as a solid-state phosphor material for high-power LED color conversion. It is made with low-temperature melting glass (LMG), which features excellent heat resistance, moisture resistance, chemical resistance and thermal conductivity compared to conventional binders like PDMS.

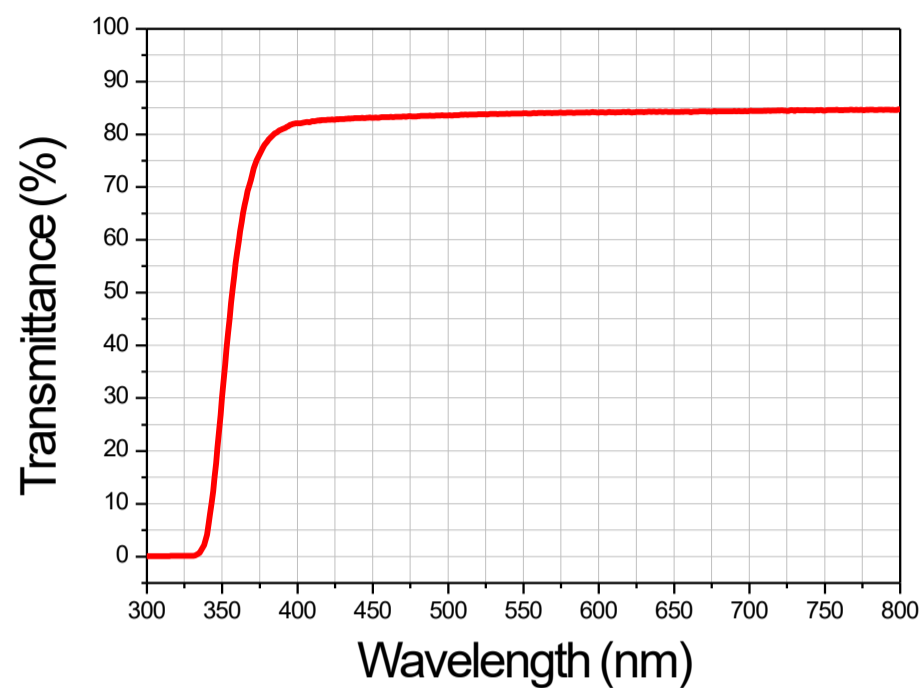
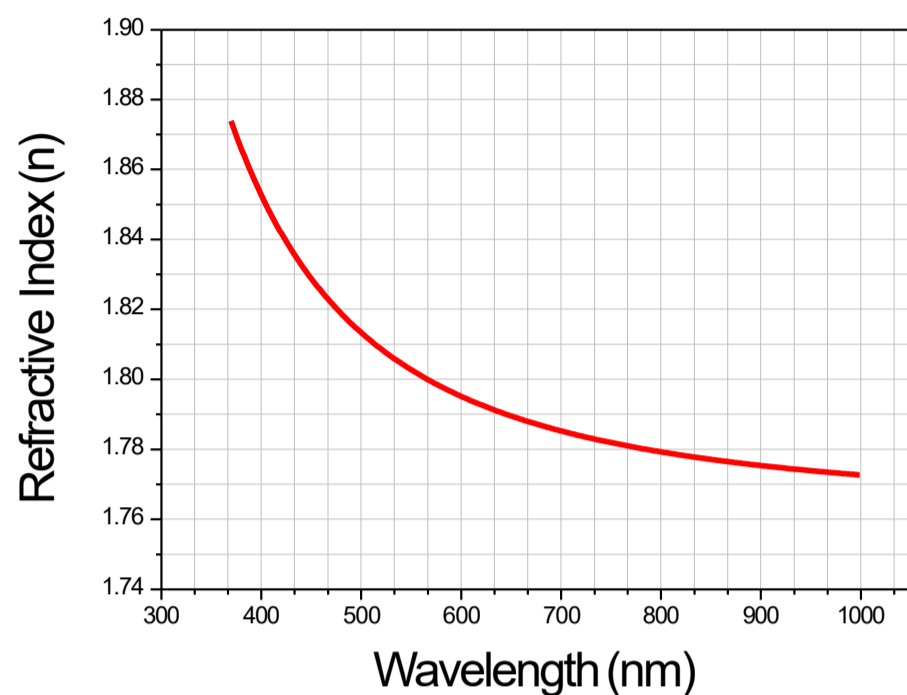
| | |
|--------------------|--|
| Application | High power LED color conversion for applications such as automobile, horticulture, and more. |
| Thickness | 120 μm to 2 mm |
| Size | Up to 4 inches |
| Phosphors | $\text{CaAlSiN}_3:\text{Eu}^{2+}$ / $\text{Y}_3\text{Al}_5\text{O}_{12}:\text{Ce}^{3+}$ / $\text{Lu}_3\text{Al}_5\text{O}_{12}:\text{Ce}^{3+}$ / Ca- α -SiAlON: Eu^{2+} Other phosphors may be eligible for encapsulation. Please inquire for more details. |

CaAlSiN₃:Eu²⁺ PiG and Cross-sectional Microstructure Image



➤ YEK's PiG can be customized to your desired dimensions and specifications.

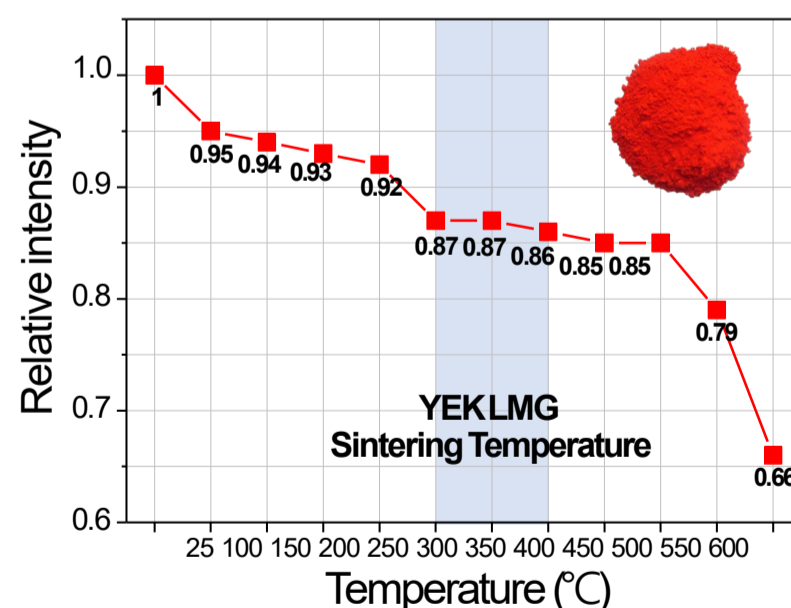
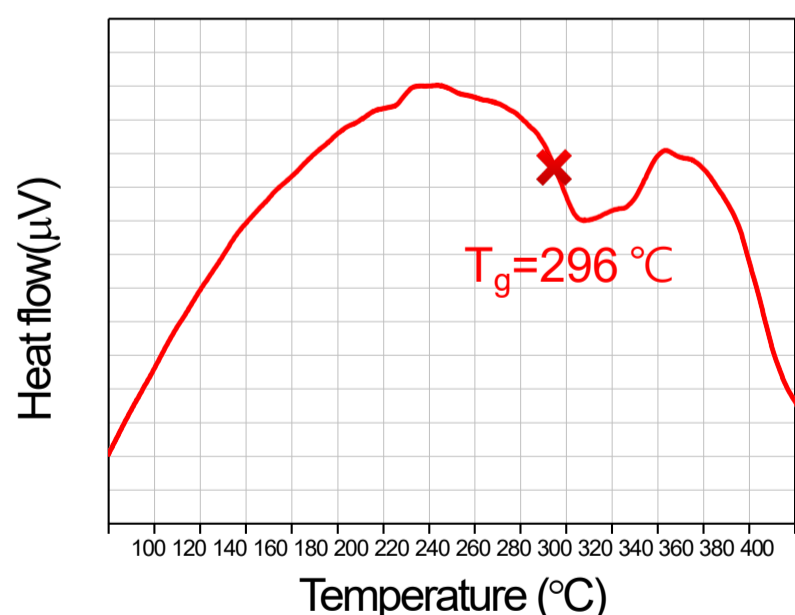
▪ Refractive Index and Transmittance of Low Melting Glass Matrix



➤ YEK Glass' LMG material has a high refractive index and superior transmittance for excellent photoluminescence performance. (@ 450 nm)

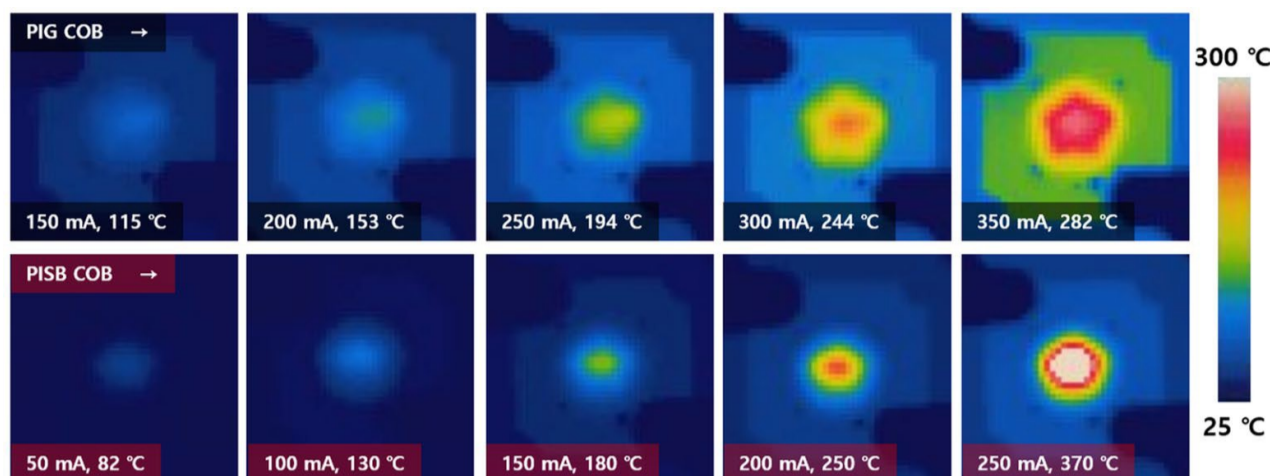
▪ LMG DTA and Thermal Degradation of $\text{CaAlSiN}_3:\text{Eu}^{2+}$ Phosphor

| Spec | D50 (μm) | D90 (μm) | CTE ($\times 10^{-7}/\text{C}$) | T _g ($^{\circ}\text{C}$) | T _w ($^{\circ}\text{C}$) | Color |
|---------|-----------------------|-----------------------|-----------------------------------|---------------------------------------|---------------------------------------|-------------|
| YPF 002 | 10.0 \pm 10 | 55.0 \pm 10 | 115.0 \pm 10 | 290 \pm 10 | 330 – 350 | Transparent |
| YPF 003 | 10.0 \pm 10 | 55.0 \pm 10 | 110.0 \pm 10 | 250 \pm 10 | 290 – 320 | Transparent |



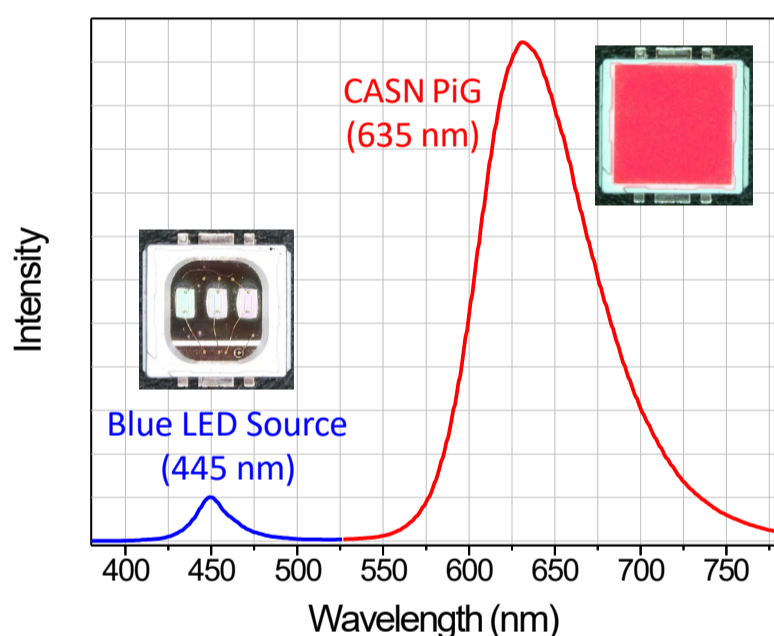
➤ YEK's LMG material features low working temperature, which allows the use of phosphors which are typically prone to thermal degradation.

▪ Heat Flux Images with Increasing Current in PiG vs. PiSB on COB



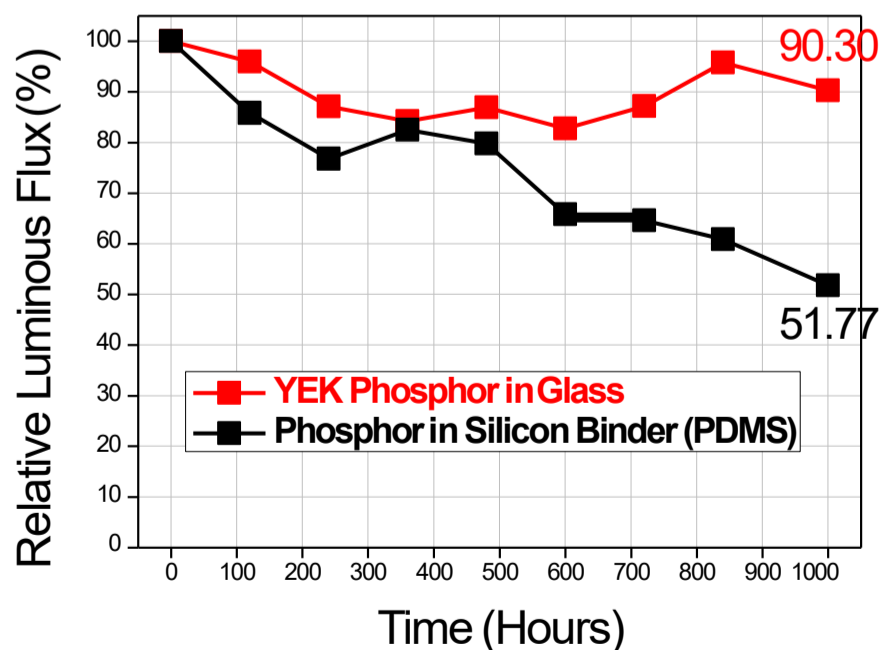
➤ YEK's LMG material has excellent thermal conductivity, dissipating excess heat from LED chips generated at high power outputs and preventing the thermal degradation of phosphors and maintaining outstanding luminous efficiency.

▪ EL Spectrum of $\text{CaAlSiN}_3:\text{Eu}^{2+}$ PiG on High Power LED



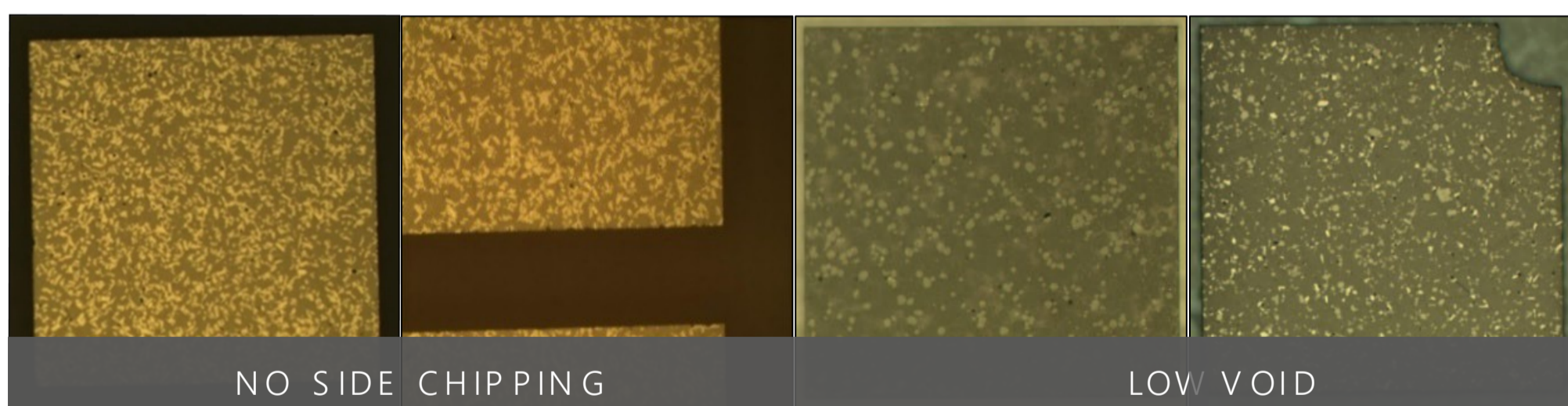
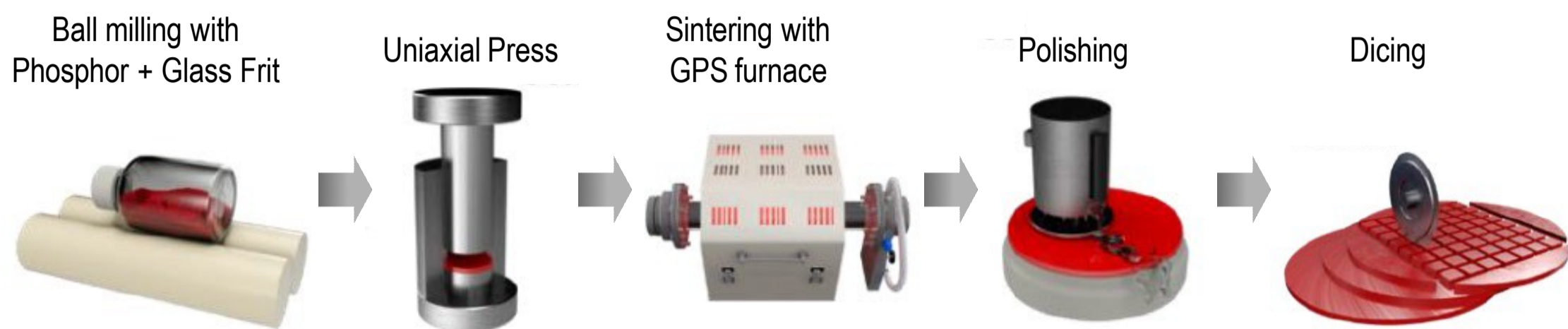
➤ Phosphor in Glass showed high emission intensity and the same peak wavelength as the phosphor in the electroluminescence spectrum.

▪ Comparison of Luminous Flux at 85 RH% / 85 °C of PiG vs. PiSB



➤ After 1,000 hours of testing (85 RH% / 85 °C), PiG showed greater reliability than silicone. (54.5 lm @ 25 °C, 350 mA, 1 W in lab.)

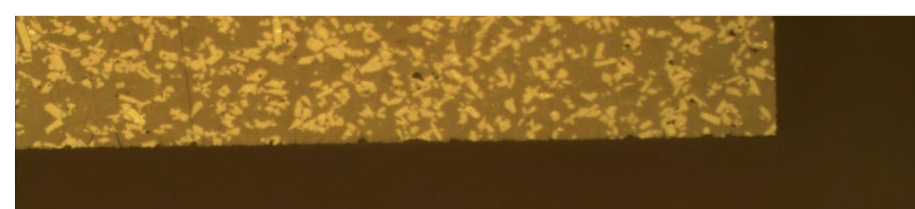
PHOSPHOR IN GLASS PROCESS



Our Competitors



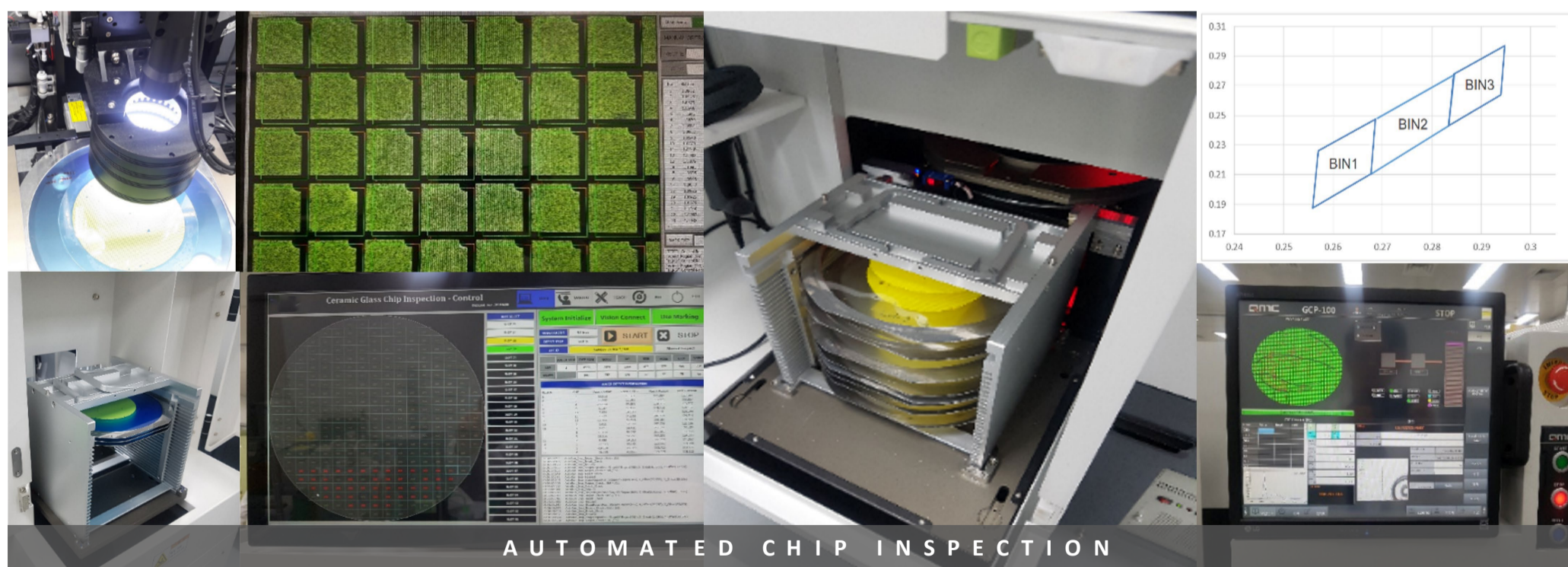
YEK Glass (Chipping-Free)



PHOSPHOR IN GLASS QUALITY CONTROL

YEK Glass strives to create precision components with high manufacturing standards. Our process focuses on:

- **Precise chip fabrication**
 - Chip thickness tolerance of $\pm 2\mu\text{m}$
 - Fracture free dicing process for high quality and yield
- **Fully automated chip inspection**
 - Meticulously analyses chip sizes, cracks, voids, and chipping
- **Strict chip color distribution control**
 - Optimized PIG manufacturing process for precise color distribution
 - Color measuring resolution : CIE x, y $\leq \pm 0.001$
- **Chips sorted into target color bins**
 - Target color bin can be determined by customer





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