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Supporting Information

Phosphor-Converted Warm White Laser Diodes with High Saturation Threshold Through PiGF-Dual Sapphire Converter

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Thermal simulation

The heat power was calculated by the difference between laser power and light power of R-PiGF-D ($P_{heat} = P_{laser} - P_{light}$), ($P_{laser}$=8 W/mm^2). A deposited beam power which consistent with the Gaussian distribution is applied on the PiGF ($f(o,e) = \frac{1}{2\Pi\sigma^2} exp\left(-\frac{d^2}{2\sigma^2}\right)$). The x-position and y-position of beam source are fixed in space at 7.5 mm and 7.5 mm, whereas the z-position of beam source is 92.5 mm. The standard deviation of beam source was used and the laser spot area was set as 1 mm^2. Based on the previous measurement of thermal conductivity [Adv. Mater. 2024, 2406147], that of the sapphire and CASN/glass film was set as 35 W·m^{-1}·K^{-1} and 1.6 W·m^{-1}·K^{-1}, respectively.

The surrounding air was held constant at 20°C. At the top and side surfaces, a convective heat flux boundary condition was used, which is driven by the temperature difference between the converter and the surrounding atmosphere: $q = h(T_{ext} - T)$. Here q is the inward heat power and h is the heat transfer film coefficient.

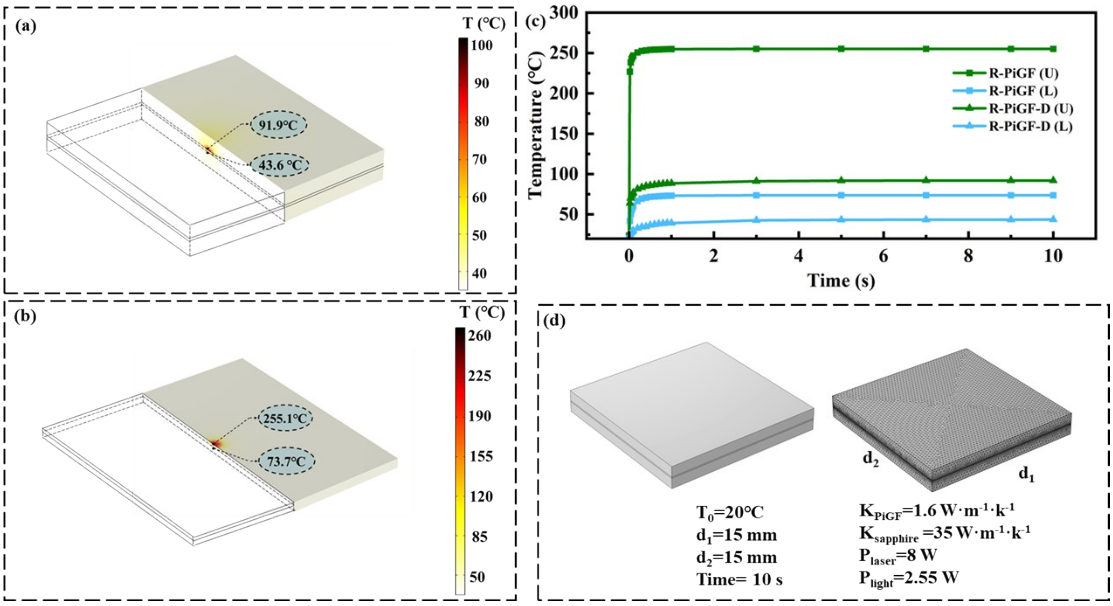

Figure S1 Simulated maximum upper and lower surface temperatures of (a) R-PiGF-D, (b) R-PiGF. (c) Two PiGF converters under various laser excitation times. (d) Thermal boundary conditions of R-PiGF-D converter.

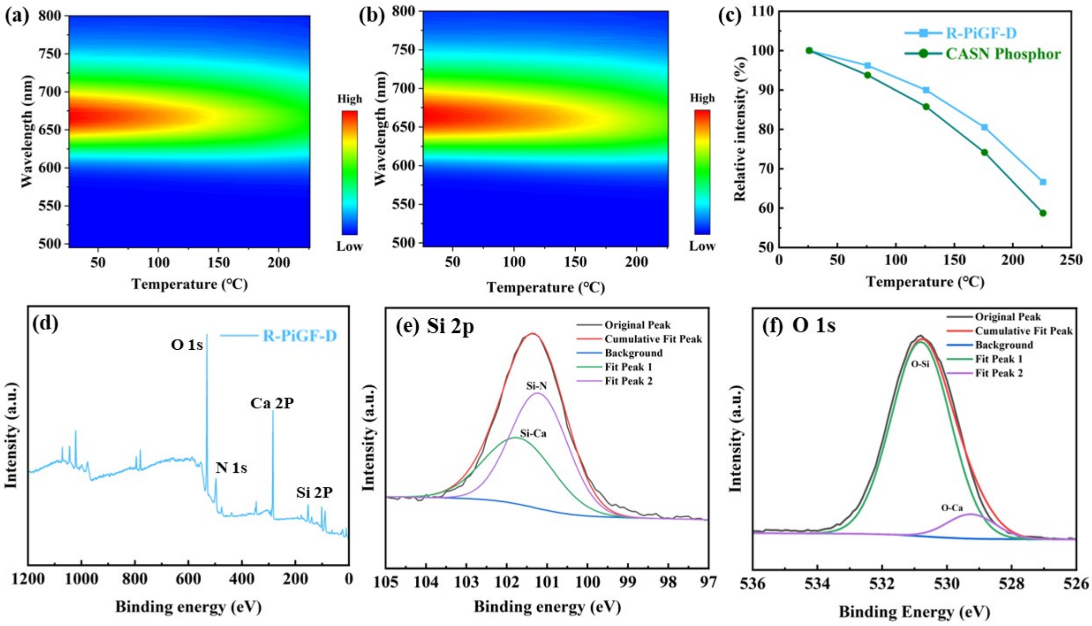

Figure S2 (a) Temperature dependent PL spectra of (a) CASN phosphor (b) CASN-PiGF. (c) Temperature-dependent relative integrated emission intensities of CASN-PiGF and CASN phosphor. Wide X-ray Photoelectron Spectroscopy (XPS) spectra of (d)R-PiGF-D and high resolutions XPS spectra of (e) Si 2p and (f) O 1s, respectively.

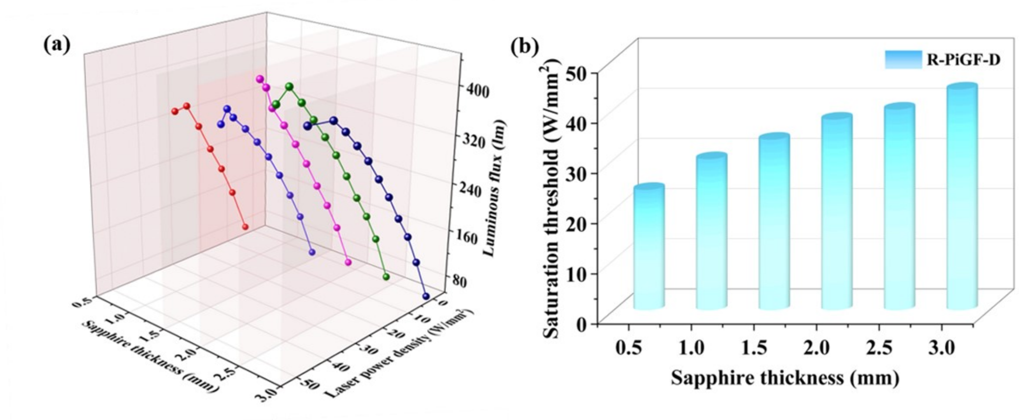

Figure S3 (a) Luminous fluxes and (b) saturation thresholds of R-PiGF-D converters with different sapphire thicknesses under various laser power densities.

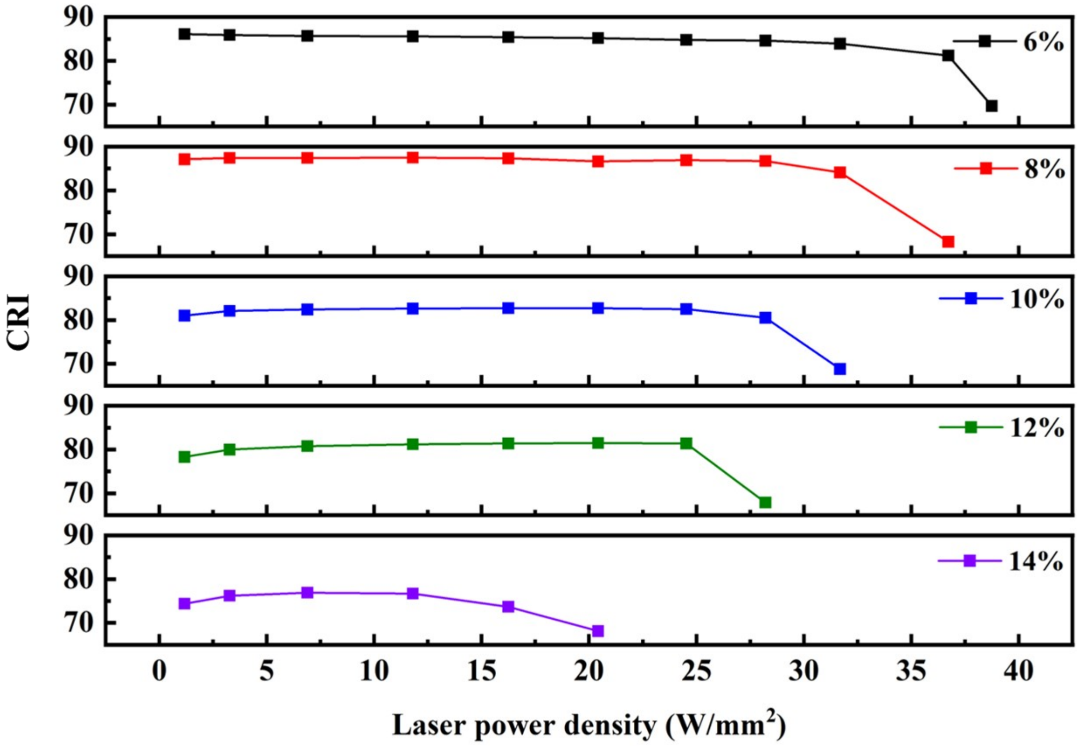

Figure S4 CRIs of Y/R-PiGF-Ds with different CASN concentrations under various laser power densities.