Supplementary Information (SI) for New Journal of Chemistry.

Supporting information

1. Chemicals and Characterization

1.1. Chemicals

Lead Bromide (99%, $PbBr_2$), Cesium Bromide (99.99%, CsBr), Tetramethyl orthosilicate (99%, TMOS), *n*-hexane (99%), were purchased from Aladdin. Oleic acid (85%, OA) was ordered from Alfa Aesar. Oleylamine (85%, OAm) was ordered from InnoChem. N,N-Dimethylformamide (99%, DMF), Ammonia (25%) were purchased from Macklin. Toluene (99%) was ordered from Titan. Strontium aluminate (99%, $SrAl_2O_4$) was ordered from YuMingJie. All chemicals were utilized without further purification.

1.2. Characterization

The morphology and elemental distribution of the as-synthesized samples were examined using a field-emission scanning electron microscope (FE-SEM, Hitachi S-4800, Japan). Powder samples were directly adhered to conductive tape and sputter-coated with a thin gold layer prior to imaging to enhance conductivity. Transmission electron microscopy (TEM), high-resolution TEM (HRTEM), and energy-dispersive X-ray spectroscopy (EDS) mapping were performed on a JEM-2100 microscope (JEOL, Japan). Samples were dispersed in ethanol via ultrasonication for 5 min, and a drop of the suspension was deposited onto a copper grid and dried before observation.

X-ray diffraction (XRD) patterns were recorded on a Rigaku D/Max 2550 diffractometer (Japan) using Cu Kα radiation ($\lambda = 1.5406$ Å) operated at 30 kV and 20 mA. Data were collected in the 2θ range of 10°–70° with a step size of 0.02° and a counting time of 1 s per step.

UV-visible absorption spectra were obtained using a Shimadzu UV-2600 spectrophotometer (Japan). Steady-state photoluminescence (PL) spectra were measured on a Shimadzu RF-6000 spectrofluorophotometer (Japan). Time-resolved photoluminescence (TRPL) decay curves were acquired using an FLS1000 fluorescence spectrometer (Edinburgh Instruments, UK).

X-ray photoelectron spectroscopy (XPS) measurements were performed on an EscaLab 250Xi spectrometer (Thermo Fisher Scientific, USA) equipped with a monochromatic Al Kα X-ray source (hν = 1486.6 eV). The binding energy scale was calibrated against the adventitious C 1s peak at 284.8 eV. Spectral deconvolution was carried out using the XPSPEAK 4.1 software, employing a Shirley-type background and mixed Gaussian-Lorentzian (Voigt) line shapes for peak fitting.

Fourier transform infrared (FTIR) spectra were recorded on a PerkinElmer Frontier spectrometer (USA).

Nitrogen adsorption-desorption isotherms were measured at 77 K using a Micromeritics ASAP 2460 analyzer (USA). Prior to analysis, samples were degassed at 120 °C under vacuum for 6 h. The specific surface area was calculated using the Brunauer-Emmett-Teller (BET) method.

A spin coater (KW-4A, Beijing Cedes Electronics Co., Ltd., China) was used for the preparation of thin films in certain device fabrication steps.

2. Supporting Figures

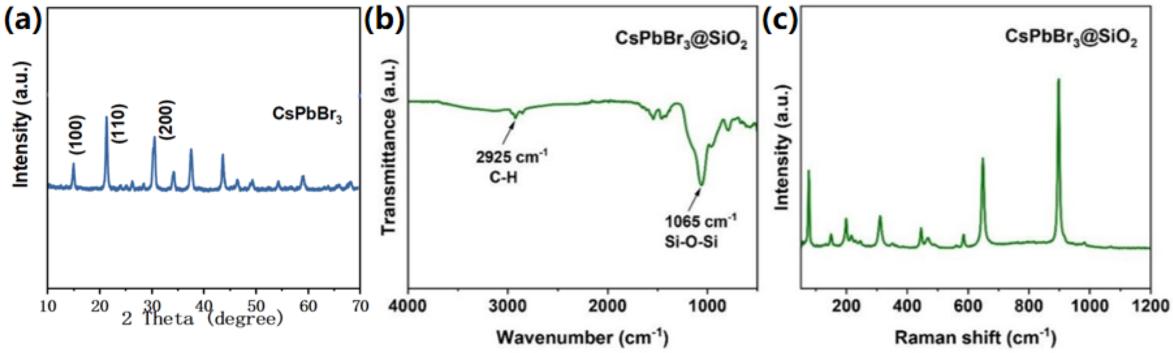

Figure S1. (a) XRD pattern of the pristine $CsPbBr_3$. (b) FTIR spectra of $CsPbBr_3@SiO_2$. (c) Raman spectrum of $CsPbBr_3@SiO_2$.

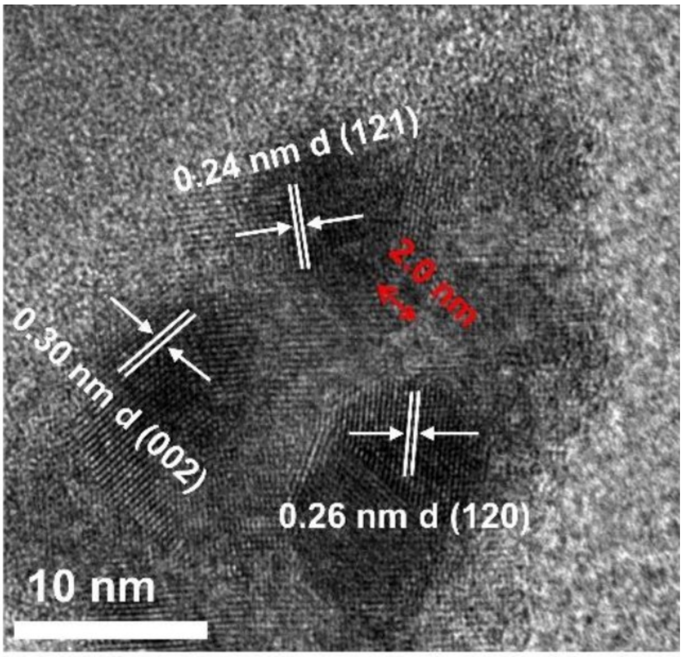

Figure S2. HRTEM image of $CsPbBr_3@SiO_2$.

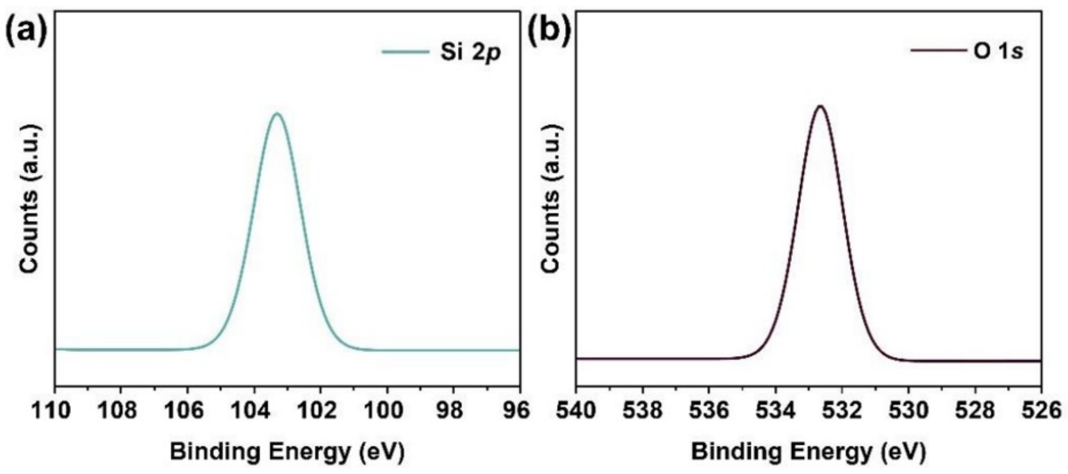

Figure S3. Si 2*p* (a) and O 1*s* (b) XPS spectra of $CsPbBr_3@SiO_2$.

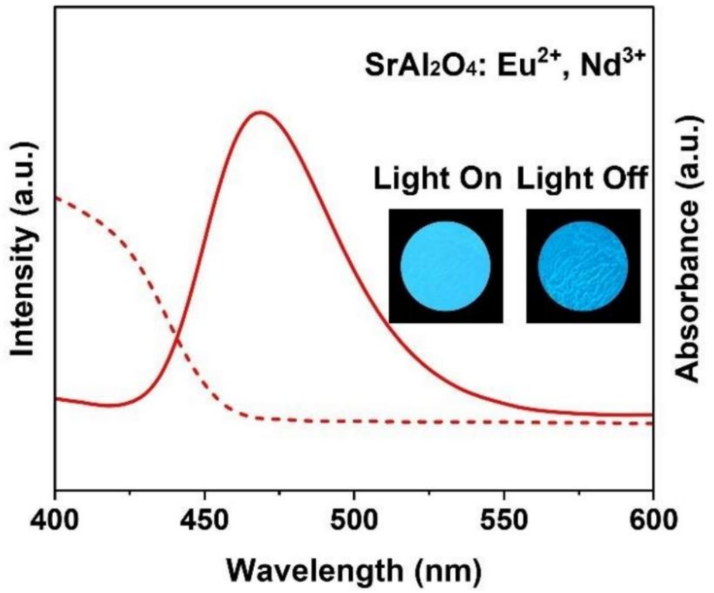

Figure S4. PL spectra and UV-visible absorption spectrum of SAO at 365 nm excitation (insets are fluorescent and afterglow photographs of SAO).

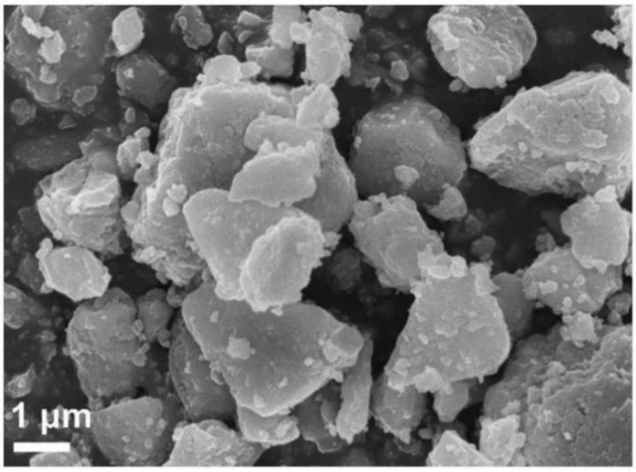

Figure S5. SEM image of SAO.

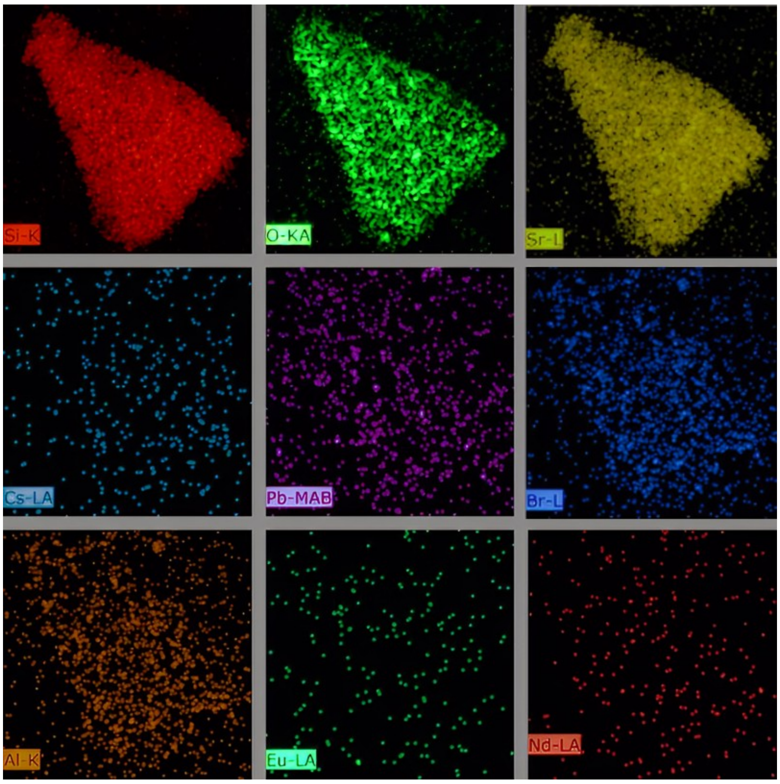

Figure S6. EDX mappings of 0.1SAO@$CsPbBr_3$@SiO_2.

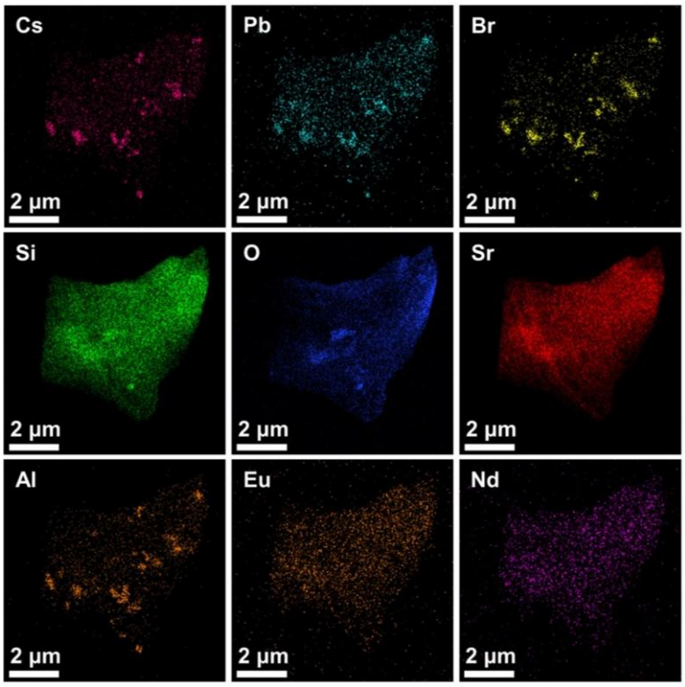

Figure S7. The corresponding elemental mapping of Cs, Pb, Br, Si, O, Sr, Al, Eu, Nd of 0.1SAO@$CsPbBr_3$@SiO_2.

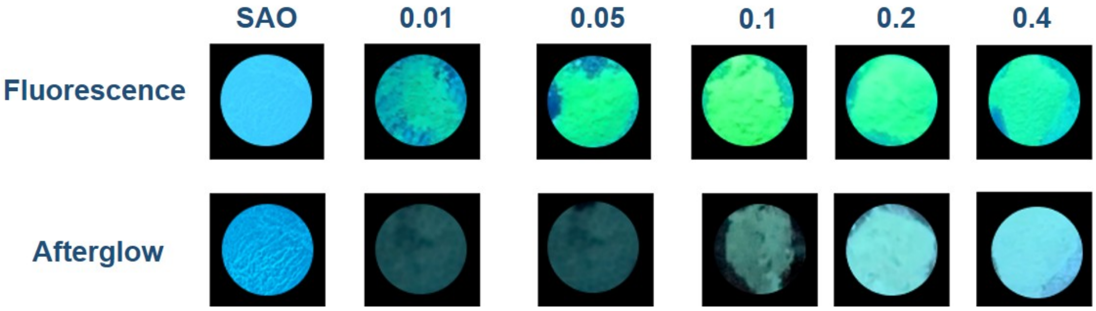

Figure S8. Fluorescence and afterglow photographs of different contents of SAO@$CsPbBr_3$@SiO_2 and SAO.

0s 30s 60s 120s

Figure S9. Time-sequence images of the "Emergency Exit" sign after UV light cessation (at 0, 30, 60, and 120 s).

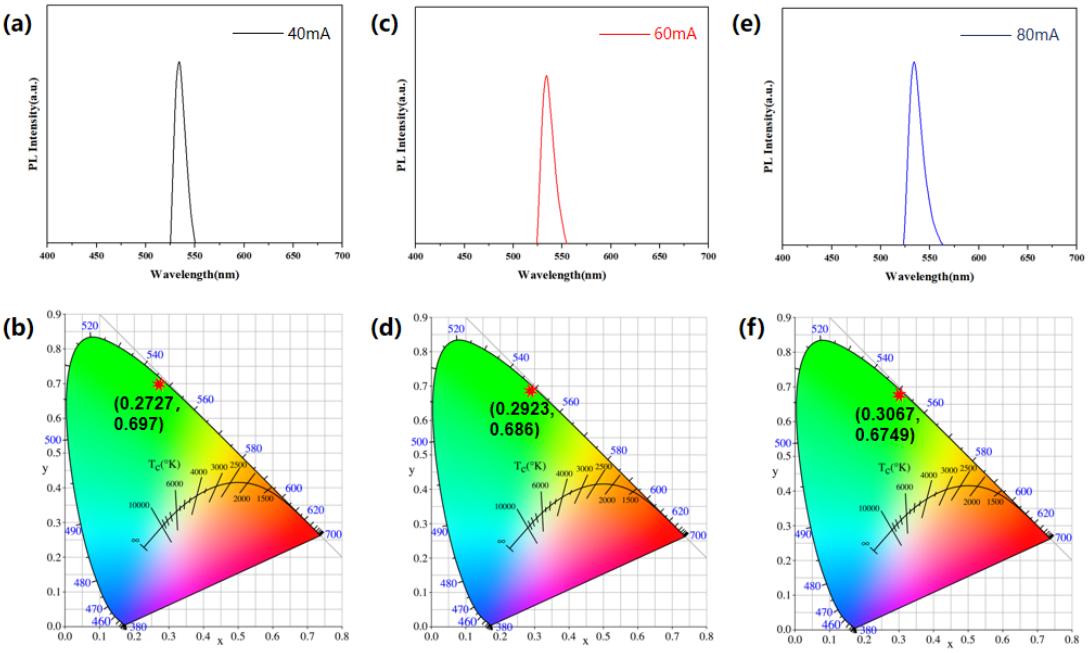

Figure S10. EL spectra and CIE coordinates of the LED at operating currents of 40 mA (a, b), 60 mA (c, d), and 80 mA (e, f).