Supplementary Information

Transparent self-powered $ZnVO_2/CdGa_2O_3$ heterostructure for integrating UV photodetection and luminescent down-conversion

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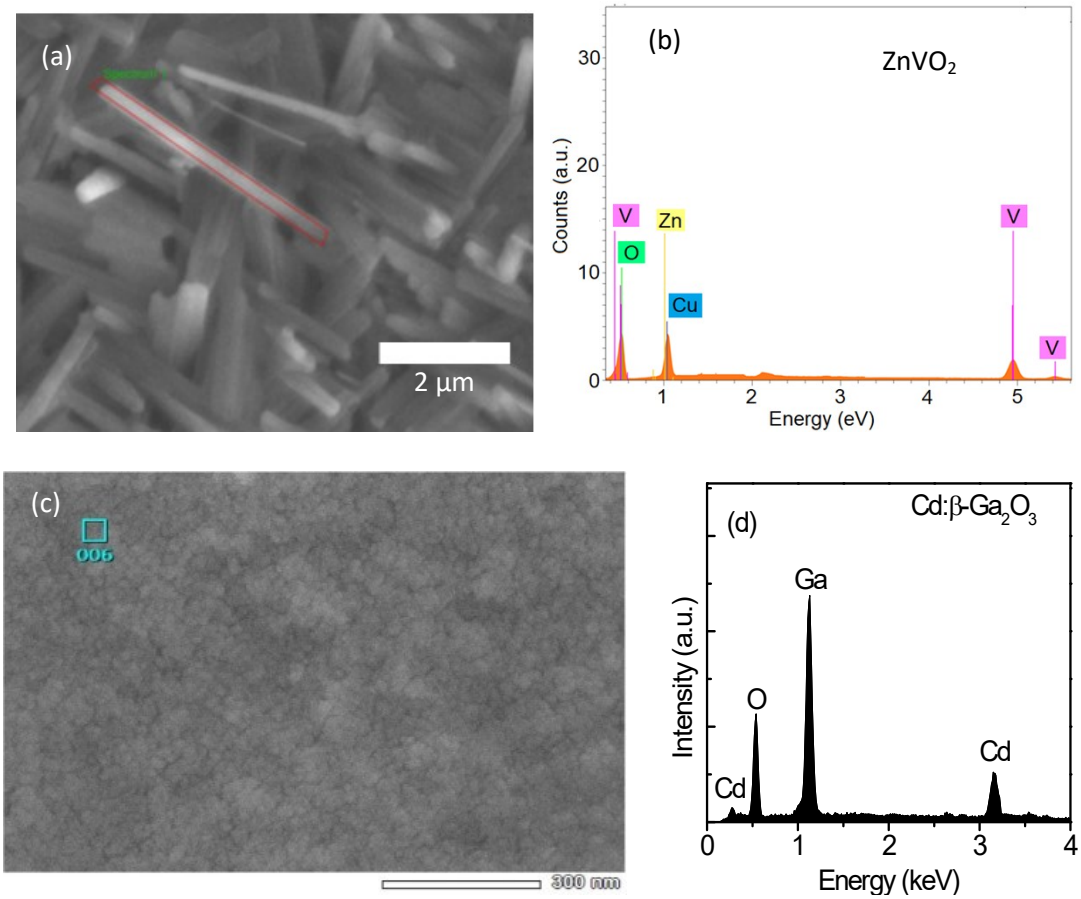

Fig. S1. EDS elemental analysis of a single Zn-doped VO_2 nanowire. (a) A single nanowire is selected for the EDS scan, indicated by the red-colored rectangular area. (b) The corresponding EDS spectra. The atomic percentage of Zn is 5%. The peak around 1 eV is due to the superposition of Cu and Zn. The Cu content is derived from the Cu tape used as the conductive substrate. (c) Secondary electron SEM micrographs and (d) the corresponding EDS spectra of $CdGa_2O_3$ films. The amount of Cd in this film is 9.95 at%.

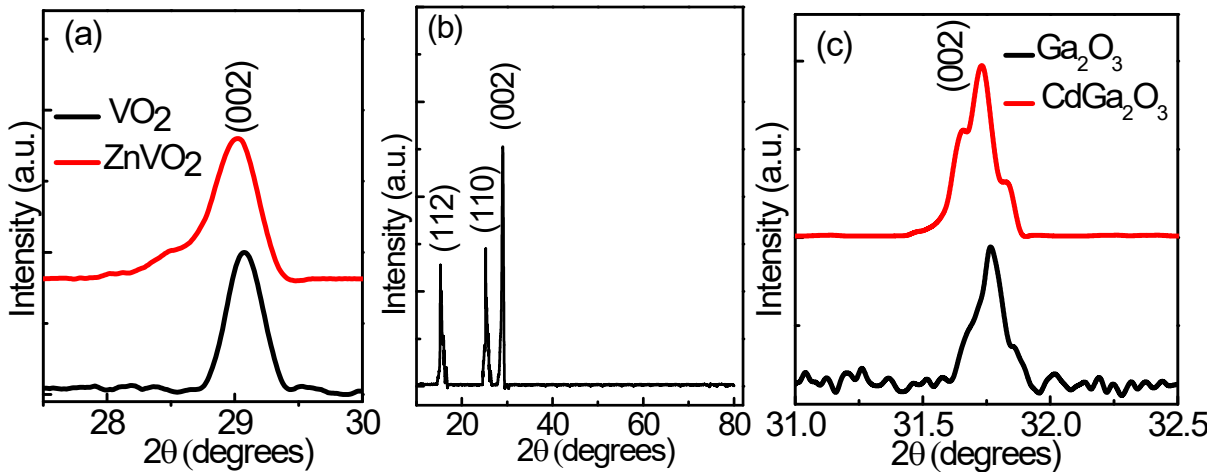

Fig. S2. (a) Magnified view of (002) crystallographic orientation of the Zn-doped VO_2(B) nanowire networks. The (002) crystallographic orientation shifts to lower Bragg angles, indicating the successful doping of Zn into the VO_2(B) host. (b) XRD pattern of Zn-doped VO_2(B) nanowire networks taken three months later by keeping the sample in the ambient environment. The X-ray diffraction pattern of the Zn-doped VO_2(B) nanowire networks remains unchanged after three months, which confirms the structural stability of VO_2(B). (c) The zoom in view of (002) XRD peak of the Cd-doped Ga_2O_3 film, and this peak shows a minor shift with Cd doping, demonstrating that Cd occupies the Ga site.

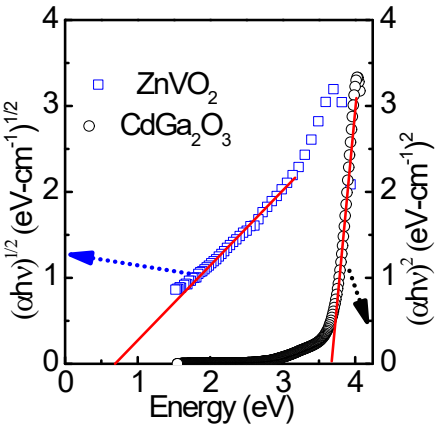

Fig. S3. Determination of optical band gap for Zn-doped VO_2 nanowires and Cd-doped Ga_2O_3 film using Tauc's plot. The optical bandgap is found to be 3.68 eV for Cd-doped Ga_2O_3 film and 0.68 eV for Zn-doped VO_2 nanowires.

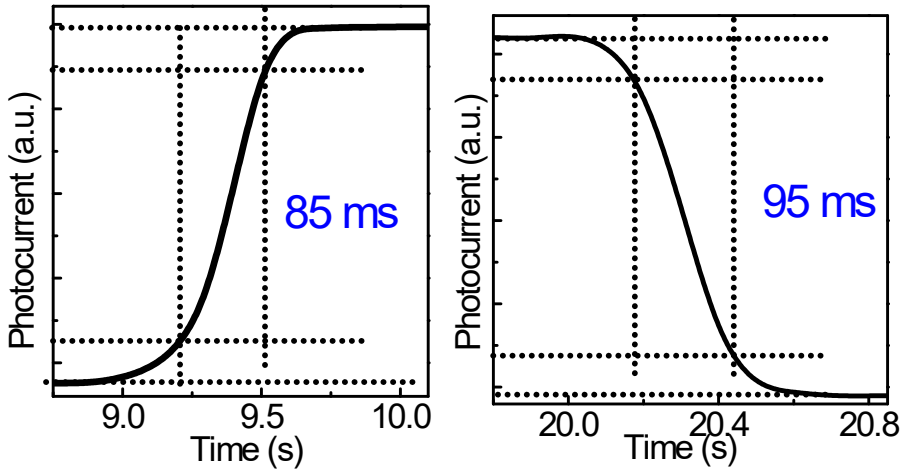

Fig. S4. Determination of (a) rise and (b) decay time constants for $ZnVO_2/CdGa_2O_3$ heterojunction. The rise and decay time constants are 85 and 95 ms, respectively.

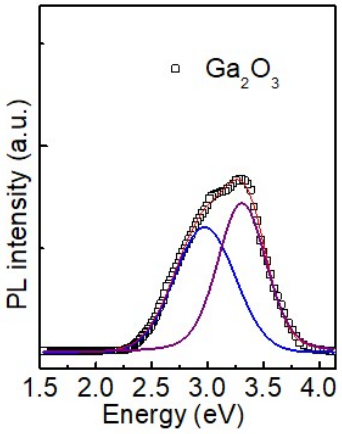

Fig. S5. Deconvolution of the PL spectra of Ga_2O_3 shows the UV and BL emissions at 3.30 and 2.98 eV, respectively.

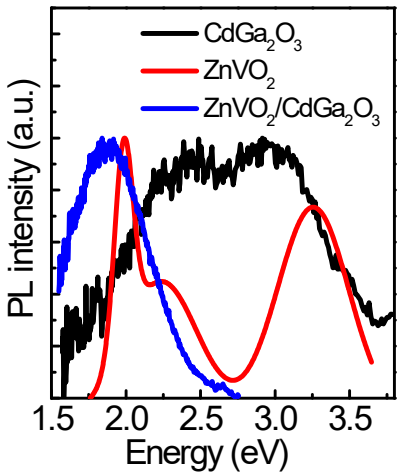

Fig. S6. Comparison of the normalized PL spectra of $ZnVO_2$ nanowire, $CdGa_2O_3$ film, and $ZnVO_2/CdGa_2O_3$ heterostructure. The PL peak position and spectral line shape of the heterostructure are different from those of the individual layers, indicating that the orange-red emission originated from the heterostructure.

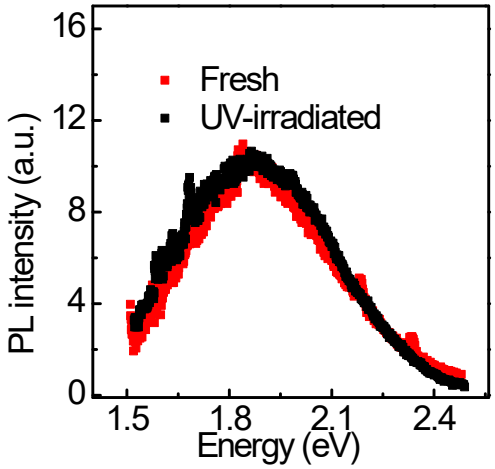

Fig. S7. The steady-state PL spectra were collected from the fresh and UV-irradiated device. No change of spectral line shape or peak position is observed, indicating stable, durable emission from the devices.

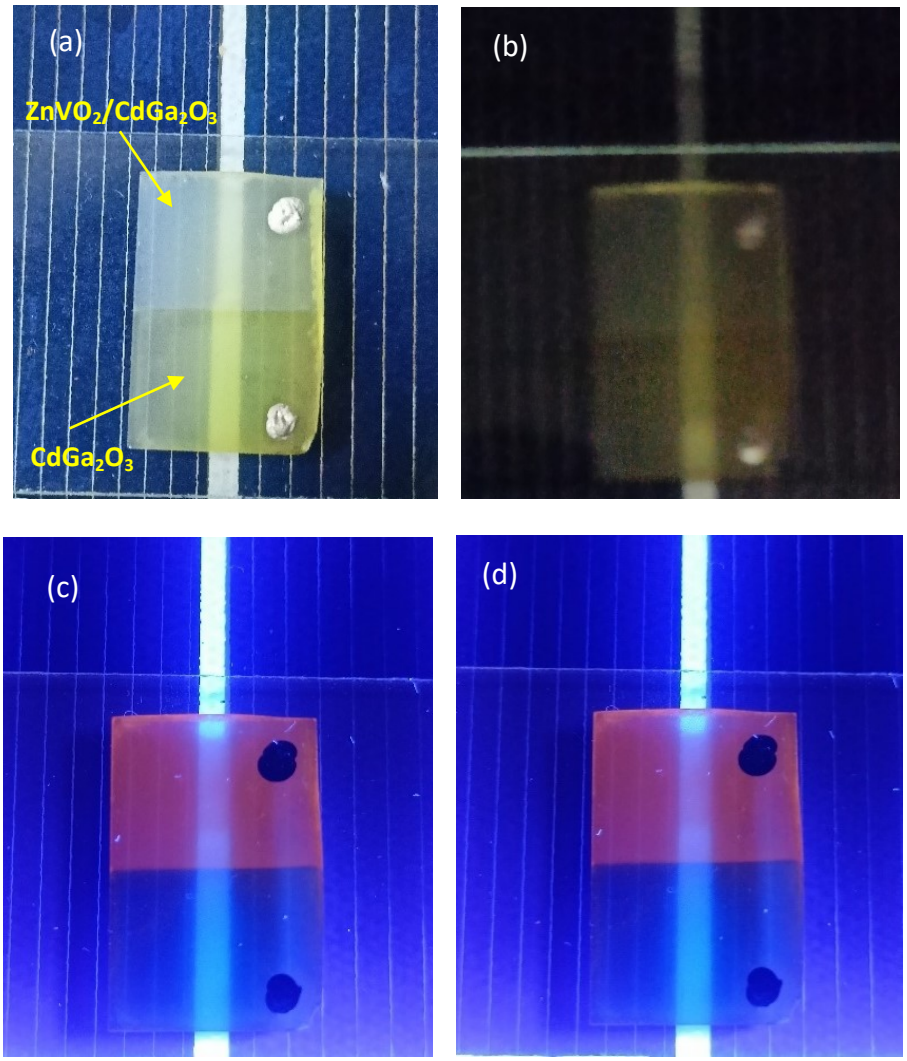

Fig. S8. The photographs of the $ZnVO_2/CdGa_2O_3$ device in (a) daylight, (b) dark, (c) the first minute, and (d) the last minute of one hour of 360 UV irradiation. The light intensity remains unchanged after 1 hour of UV irradiation, indicating that the light emission from the sample is stable.