Supplementary Information

Self-protective GaInN-based light-emitting diodes with VO_2 nanowires

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Fig. S1 Vapor transport growth of VO_2 nanowires

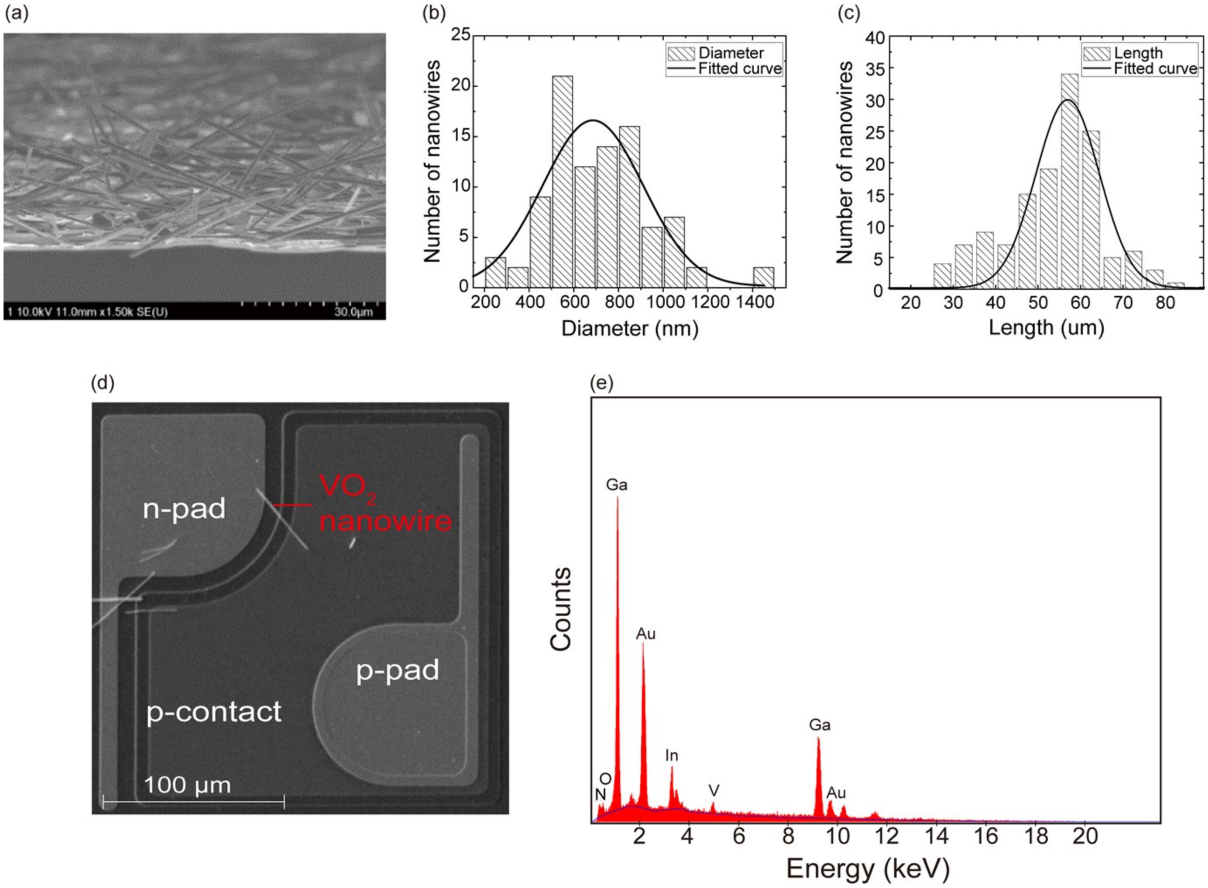

Fig. S1 (a) SEM image for VO_2 nanowires after vapor transport growth. Histograms and corresponding Gaussian fits showing the distribution in (b) the diameter and (c) the length of VO_2 nanowires. (d) top-view SEM image and (e) EDX data for self-protective LED.

VO_2 nanowires were synthesized by the vapor transport method. The SEM image after vapor transport method and their dimension ranges including diameter and length are provided. The average values of the diameter and length of VO_2 nanowires were estimated to be 685.44±230.89 nm and 57.56±11.17 µm, respectively, via Gaussian fits. VO_2 nanowires do not show nice and sharp dimension range due to challenges on the dimension control during the growth process. The VO_2 synthesis condition can be optimized further which is our on-going project. However, in this work, we demonstrated self-protective properties using MIT behavior based on VO_2 nanowires as a proof of concept. The Fig. S1(d) is top-view SEM image for self-protective LED. It can be clearly shown that VO_2 nanowire adhered to the pad metal of the LED. In addition, the corresponding EDX in Fig. S1(e) shows the clear existence of V atoms.

Fig. S2 Reproducibility test on the self-protective LEDs

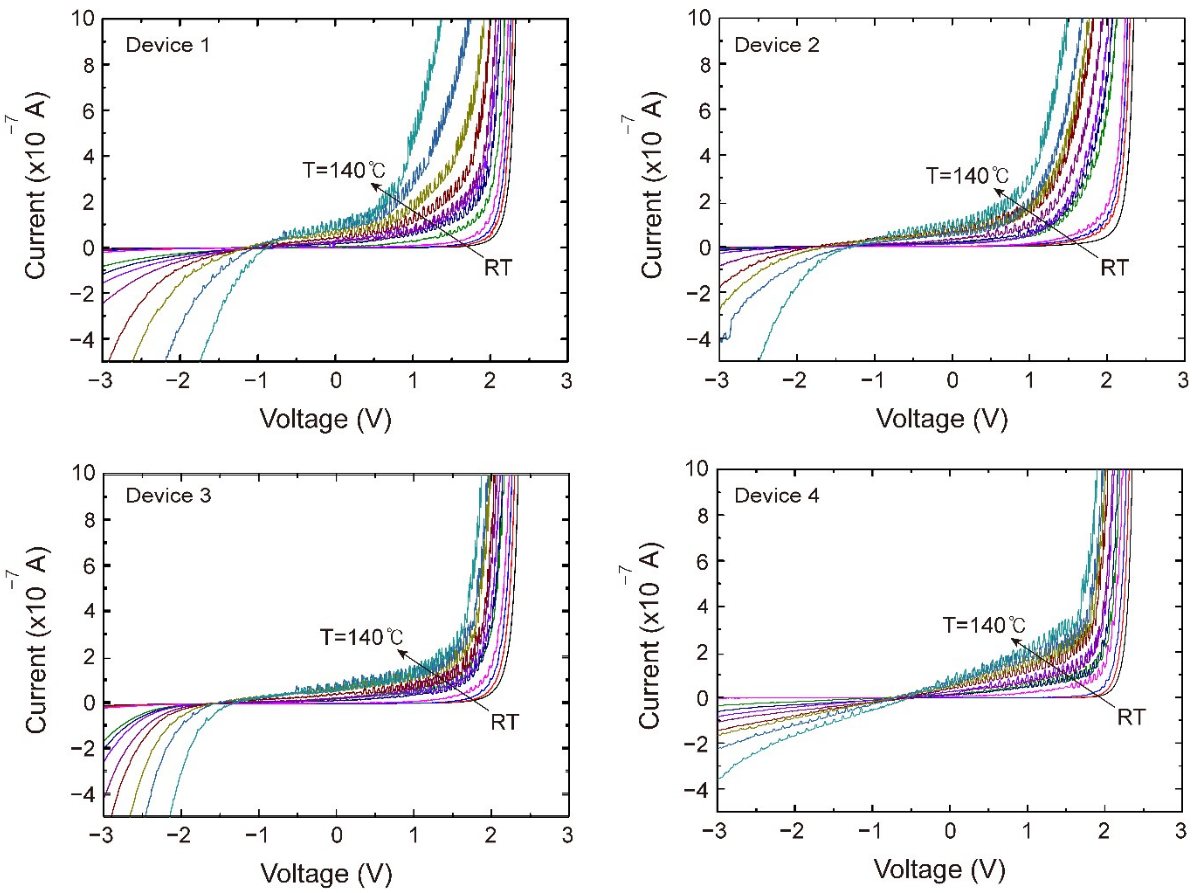

Fig. S2 Temperature-dependent I-V measurement results for various self-protective LED samples.

We have investigated more than 30 LEDs having inter-connected VO_2 nanowires. Most of such LEDs show self-protective effect. Although there are small differences in temperature dependency due to non-uniformity and dimension distribution in length and diameter of nanowires, all LEDs show self-protective effect.

Fig. S3 Voltage-current and voltage-time measurement results

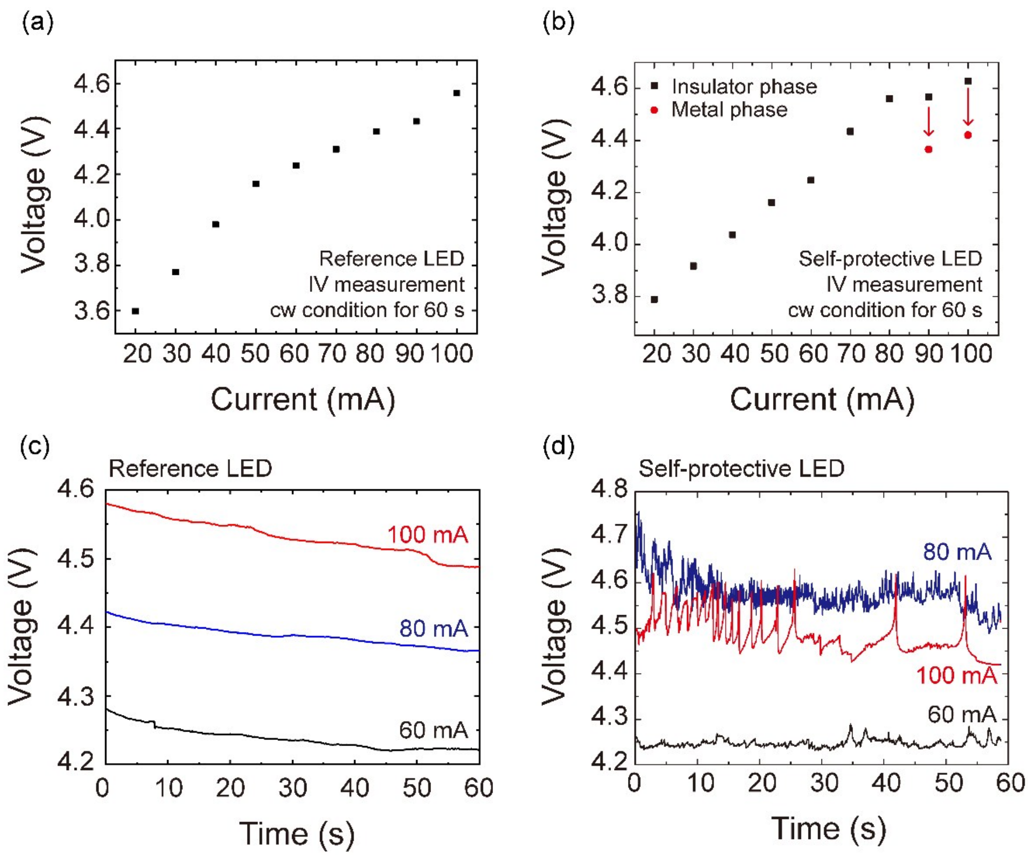

Fig. S3 Voltage-current plots in *cw* current condition for (a) reference LED and (b) self-protective LED and voltage-time measurement for *cw* current conditions of 60, 80, and 100 mA for (c) reference LED and (d) self-protective LED.

I-V characteristics under *cw* operation characteristics of the reference LED was also investigated, as shown in the figure above. The reference LED shows a typical behavior in voltage under *cw* current injection (gradual increase in voltage as the *cw* current increases), while the self-protective LED shows a large drop for currents above 90 mA caused by phase transition of the VO_2 nanowires.