Supplementary Information

Asymmetric light propagation in composition-graded semiconductor nanowires

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1. EDS information along the length of a composition-graded nanowire.

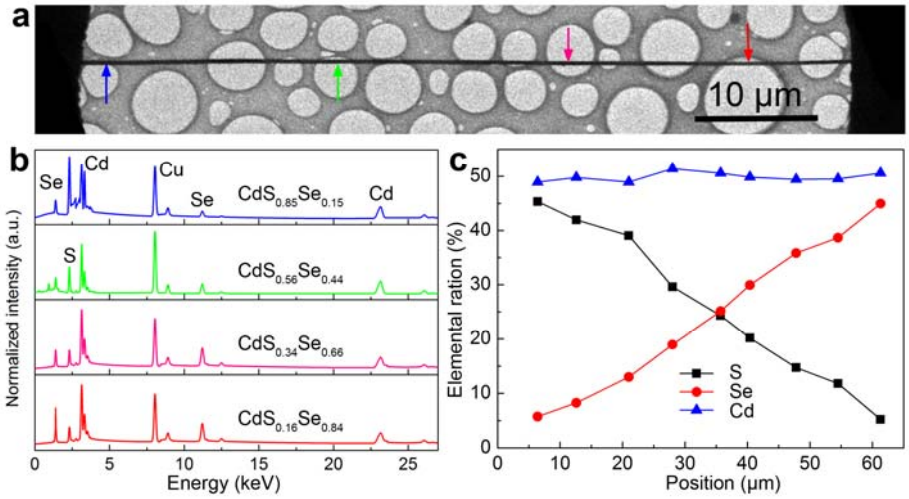

Figure S1 | (**a**) TEM image of a single composition-graded nanowire. (**b**) EDS spectra collected from four representative regions along the nanowire. (**c**) Elemental ratio along the length of the nanowire.

2. Local PL spectra collected from different positions of a composition-graded CdSSe alloy nanowire.

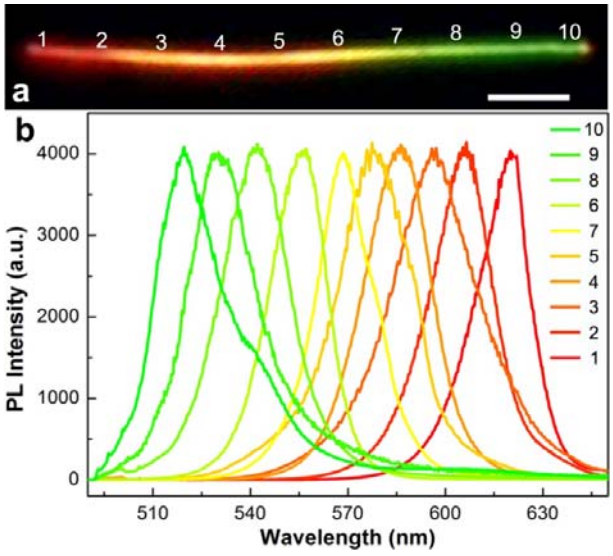

Figure S2 | (**a**) Real-color PL photograph of a composition-graded nanowire under the illumination of a diffused 405-nm semiconductor laser. (**b**) Locally collected PL spectra from different positions along the nanowire. Scale bar, 10 μm.

3. Optical waveguiding along the two opposite direction of a composition-graded CdSSe nanowire, with local excitation at variable positions.

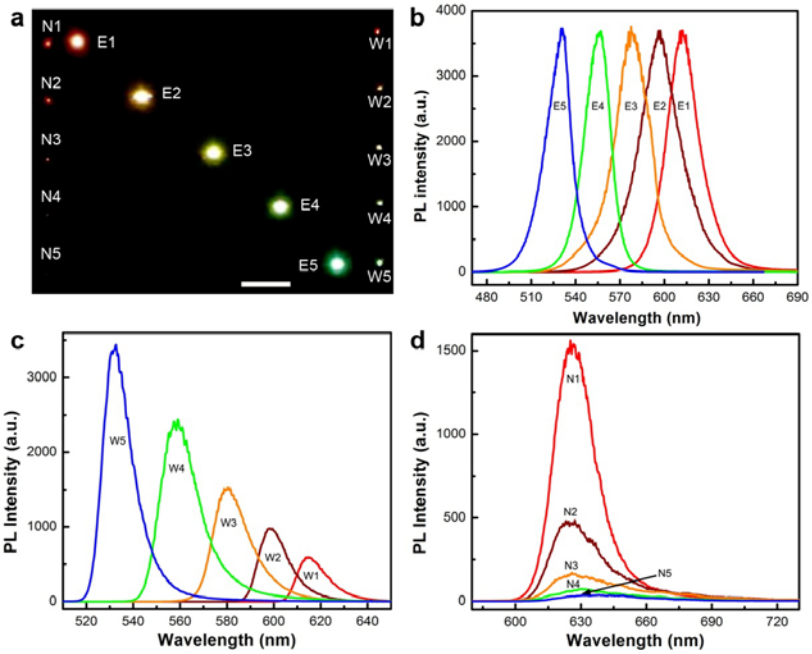

Figure S3 | (**a**) Real-color photographs of the bandgap-graded nanowire, with local excitation at different positions (E1-E5) along its length. W1-W5 and N1-N5 showing the emission of the guided light at the WBG and NBG ends, respectively. Scale bar, 10 μm. (**b-d**) Locally PL spectra detected at the excitation positions (**b**), WBG ends (**c**) and NBG ends (**d**).

4. σ and S_0 for theoretical simulation of asymmetric light propagation

For the theoretical simulation, σ is a composition-dependent dimensionless phenomenological fitting parameter which behaves as[1]

$$\sigma = \sigma_0 \frac{2kT}{h\omega_0} \tanh\left(\frac{h\omega_0}{2kT}\right) \tag{6}$$

Here σ_0 and ω_0 is composition-dependent in the follow manner

$$\sigma_0 = \sigma_{0(\mathrm{CdS})} \times x + \sigma_{0(\mathrm{CdSe})} \times (1-x) \tag{7}$$

$$h\omega_0 = h\omega_{0(\mathrm{CdS})} \times x + h\omega_{0(\mathrm{CdSe})} \times (1-x) \tag{8}$$

where x is the composition ratio of S to (Se+S), which was calculated according to the detected PLs, x=0.254 for the NBG end and x=0.916 for the WBG end, respectively. $\sigma_{0(\mathrm{CdS})}$=2.8 eV,$\sigma_{0(\mathrm{CdSe})}$=2.3 eV, $h\omega_{0(\mathrm{CdS})}$=38.0 meV, $h\omega_{0(\mathrm{CdSe})}$=27.0 meV[2].

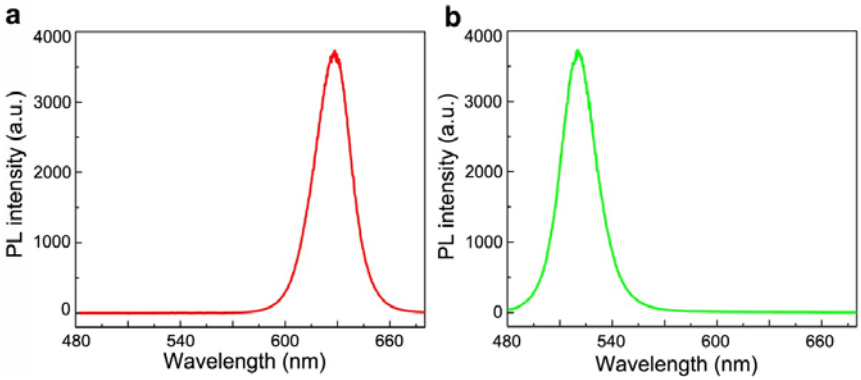

Figure S4 | The initial input spectra (S_0) at the NBG end (**a**) and at the WBG end (**b**) for theoretically simulation of the nanowire asymmetric waveguide.

5. Interpretation of the excitation wavelength dependent intensity contrast.

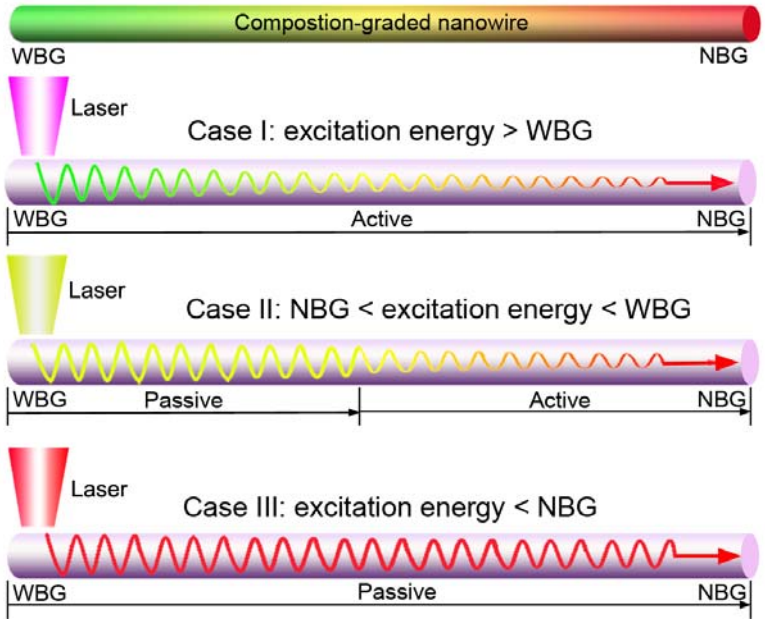

Figure S5 | Schematic mechanism of the excitation energy (wavelength) dependent backward light propagation.

When the excitation energy is above the WBG (Case I), the whole backward propagation is actively waveguiding behavior, which results in the lowest guiding efficiency along the backward, and accordingly the intensity contrast would reach the highest value since the forward propagation is an entire passive guiding. When the excitation energy locates between the WBG and NBG (Case II), the light injected from the WBG end will passively transport a certain distance before it reach the position

whose bandgap energy is the same as the energy of the injected light, and then the light further actively transport toward the NBG end. Apparently, the specific distance of the active (passive) propagation will decrease (increase) with lowering the excitation energy. Therefore, the nanowire waveguide gradually become symmetric, and the intensity contrast value will decreases with lowering the excitation energy. When the excitation energy is bellow the NBG (Case III), the backward propagation turns to entire passive waveguide, just the same as the passive forward propagation. In this case, the asymmetric effect of the waveguide cannot be preserved any more, and the intensity contrast almost close to zero.

6. Theoretical simulation of wavelength-converted waveguide.

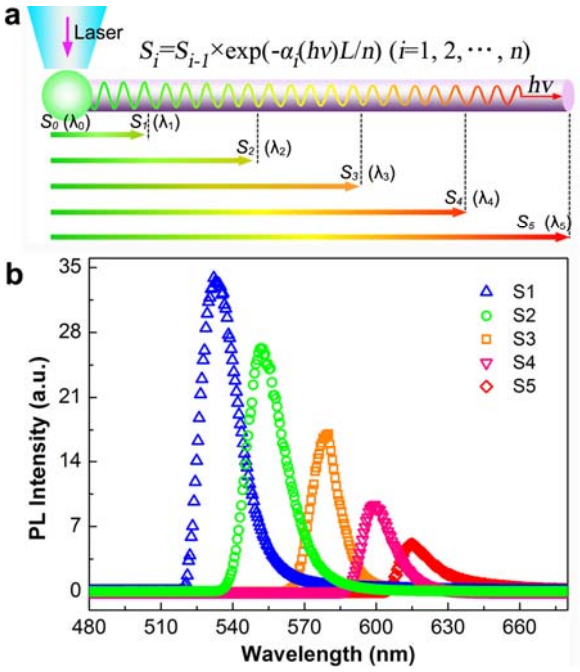

Figure S6 | (**a**) Theoretical model proposed for calculating the transmitted PL spectra along the decreased-bandgap direction. (**b**) Five representative calculated PL spectra at different transmitted distances. [L=70 μm, $E_g(0)$=2.39 eV, and $E_g(L)$=2.05 eV, S_0 is given by the *in situ* emission at the WBG end (see Fig. S3); during the simulation, the nanowire is divided into n=70 sections (L/n=1 μm each)]

Supplementary References

[1]. H. Mahr, Ultraviolet absorption of KI diluted in KCl crystals als. *Phys. Rev.* **125**, 1510-1516 (1962).

[2]. L. Samuel, Y. Brada, R. Beserman, Fundamental absorption edge in mixed single crystals of II-VI compounds. *Phys. Rev. B* **37**, 4671-4677 (1988).