Supplementary Information

Enhanced photoresponse and wavelength selectivity by SILAR coated quantum dots on two-dimensional WSe\textsubscript{2} crystals

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S1. Crystal growth of WSe₂ using the chemical vapor transport (CVT) method.

For synthesis of WSe₂ flakes by CVT method, tungsten and selenium precursors are placed in a vacuum seal ampoule with a stoichiometric ratio of 1:2. The ampoule dimensions had 20 cm length and inner diameter of 2.2 cm which was placed in a furnace at 850 °C for 2 weeks. The reaction products are shown in Figure S1, which are WSe₂ crystals.

Figure S1. (a) WSe₂ Crystals grown by CVT method in vacuum seal ampoule. (b) Vacuum seal ampoule used to grow WSe₂ crystals. The digital pictures reported in this Figure were taken by Soheil Ghods who is the first author of this work.
S2. Dependence of the current generated on the illumination with different intensity of optical power.

The output characterization of the CdS/WSe$_2$ under different illumination power levels of LEDs. The photocurrent increases gradually when the optical power increases from 100 µW to 18.5 mW. The increased photocurrent is mainly attributed to the increased number of photogenerated electron-hole pairs as the incident optical power increases.

Figure S2. Linear $I_{ds}$ versus optical power of LEDs under illumination of 515 nm LED with different intensities (dark, 100 µW, 700 µW, 1.5 mW, 2.3 mW, 3.5 mW, 4.7 mW, 6.5 mW, 7.7 mW, 9.5 mW, 11 mW, 12.5 mW, 13.8 mW, 15.5 mW, 16.8 mW and 18.5 mW)
S3. Nanoparticle size analysis using ImageJ software.

SEM images of nanoparticles are displayed on the WSe$_2$ flake. We use ImageJ software to analyze the size distribution of CdS nanoparticles. Figure S3 and Figure S4 show SEM images at 2 µm and 500 nm scale, respectively. The areas marked with a red line are the areas used for ImageJ analysis, and Figure S3b and Figure S4b shows the separation of nanoparticles by the software.

Figure S3. (a) SEM image of CdS nanoparticles on WSe$_2$ flake and specified area for analysis with ImageJ software. (b) Separation of nanoparticles in the SEM image using ImageJ software. (c) Diagram of nanoparticle size distribution against to the number of particles counted using the software.
Figure S4. (a) SEM image of CdS nanoparticles on WSe$_2$ flake and specified area for analysis with ImageJ software. (b) Separation of nanoparticles in the SEM image using ImageJ software. (c) Diagram of nanoparticle size distribution against to the number of particles counted using the software.
S4. Comparison of responsivity and EQE of bare WSe$_2$ and PbS/WSe$_2$.

To examine the optoelectronic parameters of the device, Responsivity and EQE of PbS/WSe$_2$ were compared with the WSe$_2$ bare flake, which showed a 1000-fold improvement in Responsivity and EQE.

![Comparison diagram of responsivity and EQE for bare WSe$_2$ and PbS/WSe$_2$ samples.](image)

Figure S5. Comparison diagram of responsivity and EQE for bare WSe$_2$ and PbS/WSe$_2$ samples.
S5. Long term stability of photodetector to periodically chopped illumination at 5 min intervals at a +2V bias voltage.

To test the stability of the photodetector, time-dependent photoresponse behavior was studied by periodically turning a visible light (515 nm) source on and off at 5 min intervals, with typical switching characteristics determined using power density of 5mW/cm² and +2V bias voltage.

Figure S6. Long term stability of photodetector to periodically chopped illumination at 5 min intervals at a +2V bias voltage.
The optical response of CdSe/WSe$_2$ and PbS/WSe$_2$ devices to pulsed light has been reported. The wavelength of the light for CdSe/WSe$_2$ and PbS/WSe$_2$ were 730 nm and 850 nm, respectively. The turn on (marked as pink regions) and turn off times are same and 10 ms. The rising and falling time for all devices are $\sim 2.5 - 3.5$ ms. These results used for calculation of photoconductive gain (G).

Figure S7. Response of the device to a pulsed light source (the turn on and turn off times are the same, at 10 ms) (a) CdSe/WSe$_2$ (b) zoom-in image of CdSe/WSe$_2$ (c) PbS/WSe$_2$ (d) zoom-in image of PbS/WSe$_2$ devices.
S7. EDS spectra of CdS, CdSe and PbS nanoparticles on WSe$_2$ flake.

To study the atomic composition of the constituent elements, EDS was performed. The results show the present CdS, CdSe, and PbS nanoparticles on WSe$_2$ flakes. The atomic composition (%) for CdS and PbS NPs are 50.4: 49.6 (Cd: S) and 50.9: 49.1 (Pb: S). Also, For CdSe sample, because WSe$_2$ flake consist of Se element, the percentage of elements cannot be correctly detected. However, the presence of Cd and Se elements indicates the good synthesis of CdSe NPs.
Figure S8. EDS spectra of CdS, CdSe and PbS nanoparticles on WSe₂ flake.