Supplementary Information

Photoresponse improvement of mixed-dimensional 1D-2D GaAs photodetectors through incorporating constructive interface states

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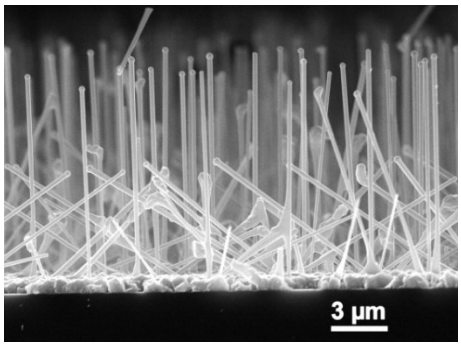

Figure S1 (a) The side-view SEM image of GaAs NWs.

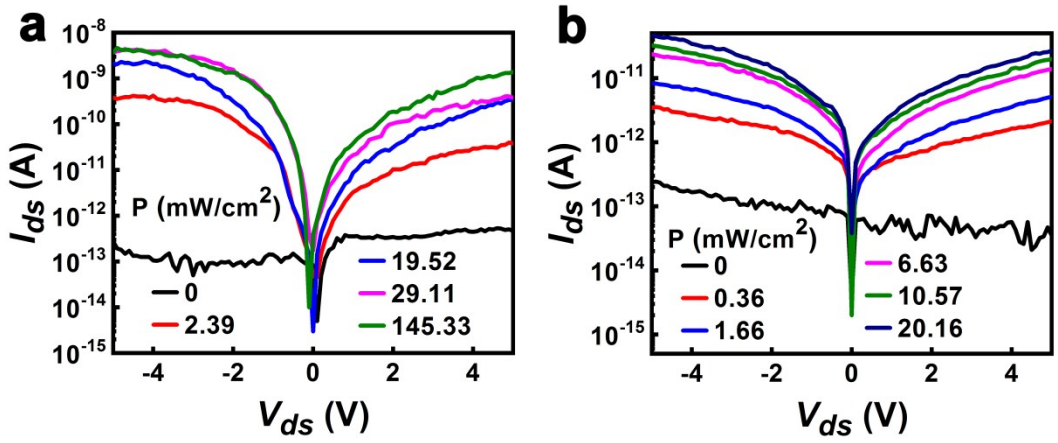

Figure S2. (a) The I_{ds}-V_{ds} curves of GaAs NW photodetector with various laser power densities. (b) The I_{ds}-V_{ds} curves of GaAs 2DNLS photodetector with various laser power densities.

The calculation method of the degree of surface bending:

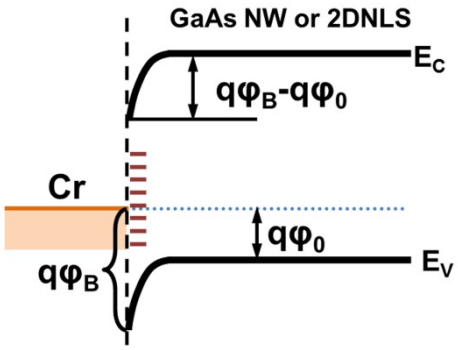

Figure S3. The degree of surface bending of GaAs NW or GaAs 2DNLS.

Along with the thermionic emission theory of Schottky junction, the barrier height (φ_B) of the active device material can be calculated by using the following equations.

$$J = J_S\left(\exp\left(\frac{qV}{nkT}\right)-1\right) \tag{1}$$

$$q\varphi_B = \frac{kT}{q}\ln\left(\frac{A^*T^2}{J_S}\right) \tag{2}$$

where J_S is saturation current density, A^* is the effective Richardson constant, k is the Boltzmann constant, T is the temperature, q is the elemental charge, and V is the applied bias voltage. The J_S is calculated to be 5.17×10^{-5} A cm^{-2} and 3.01×10^{-5} A cm^{-2} for GaAs NWs and GaAs 2DNLSs, respectively. So, the barrier height is 0.66 eV and 0.674 eV, respectively. When there are no surface states above or below the semiconductor's Fermi level, the surface Fermi level is equal to the bulk Fermi level of GaAs. At this point, the φ_0 is equal to 0.473 eV. Thus, the degree of surface bending is 0.187 eV and 0.201 eV for GaAs NWs and GaAs 2DNLSs, which can be calculated by φ_B-φ_0.

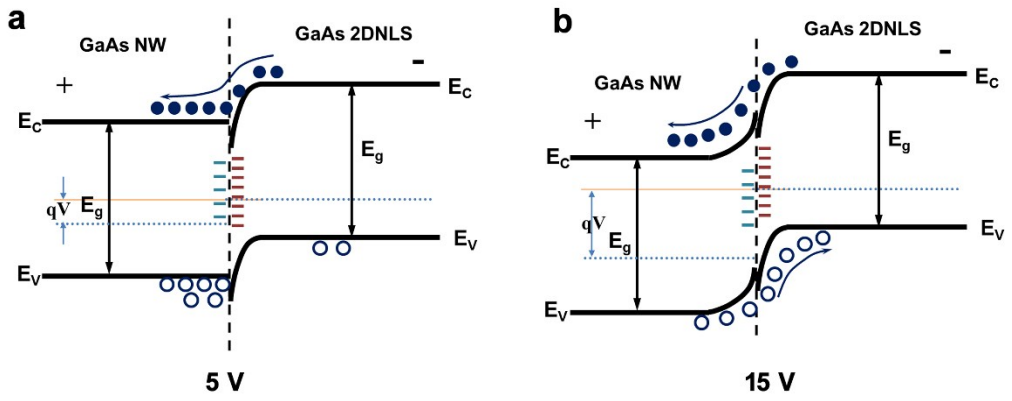

Figure S4. The band structures of the mixed-dimensional GaAs photodetector operated at (a) 5V and (b) 15V.

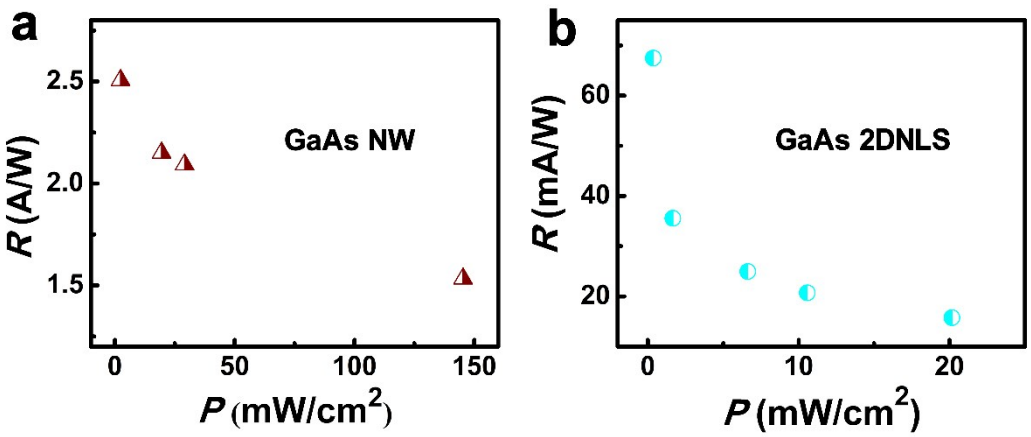

Figure S5. Dependences of *R* of (a) the GaAs NW photodetector and (b) the GaAs 2DNLS photodetector with different laser power intensities.

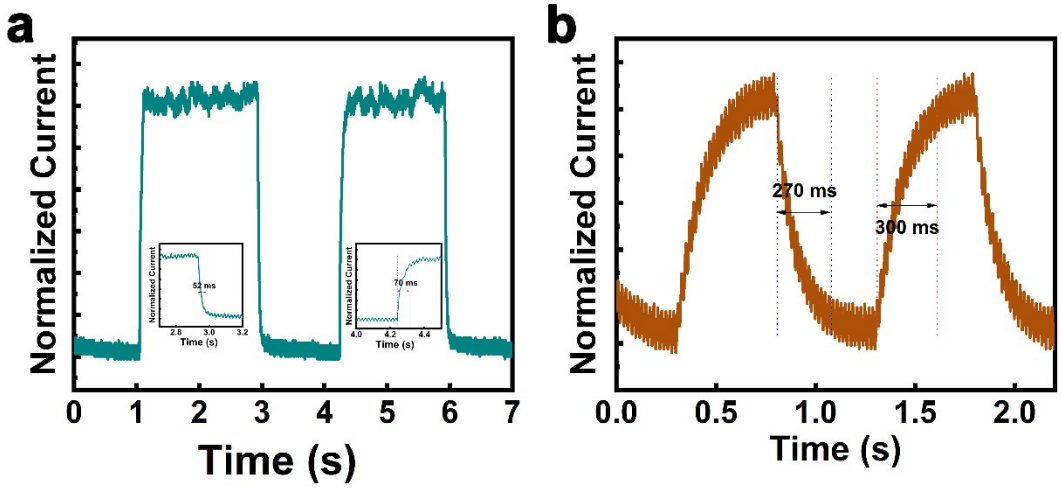

Figure S6. Time-dependent photoresponses of GaAs NW photodetector and GaAs 2DNLS photodetector.

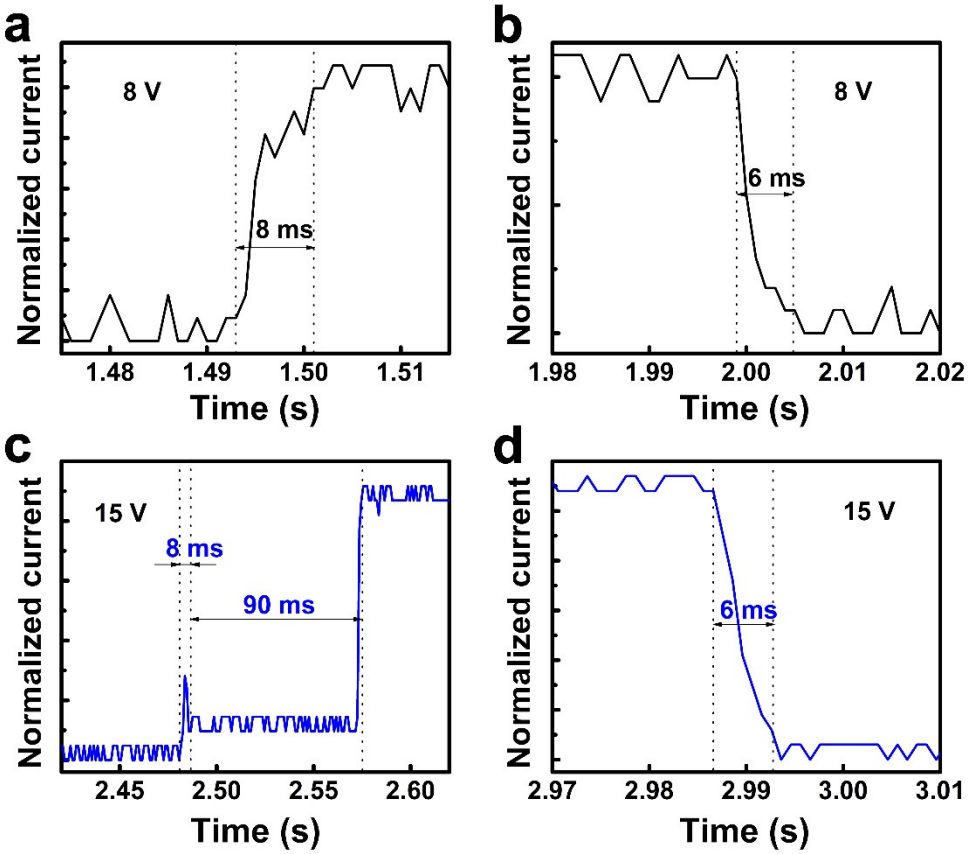

Figure S7. The rise time and decay time of mixed-dimensional GaAs NW/GaAs 2DNLS photodetector operated at a bias of (a, b) 8V and (c, b) 15V.