SUPPORTING INFORMATION

Photovoltaic Effect in Few-Layer ReS$_2$/WSe$_2$ Heterostructure

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Figure S1. AFM images of the (a) few-layer ReS$_2$ transistor and (b) few-layer WSe$_2$ transistor. The thicknesses of few-layer ReS$_2$ and WSe$_2$ transistors are approximately 3.3 and 3.5 nm, respectively.

Figure S2. Gate dependence of the few-layer ReS$_2$/WSe$_2$ heterostructure. (a) Log $I_{ds}$–$V_{ds}$ curve depending on the gate-bias, in the range of -50 V to 50 V. (b) $I_{ds}$–$V_{ds}$ curve in the p-n junction regime (-60 V < $V_{gs}$ < -30 V). At $V_{gs}$ = -50 V, the few-layer ReS$_2$/WSe$_2$ heterostructure shows the highest rectification behavior.
Figure S3. Electrical properties of the few-layer ReS$_2$/WSe$_2$ heterostructure. (a) Log $I_{ds}$–log $V_{ds}$ curve of the forward bias in the p-n junction regime ($V_{gs} = -50$ to -30 V) and in the n-n junction regime ($V_{gs} = -25$ to 50 V). (c) Log $I_{ds}$–log $V_{ds}$ curve of the reverse bias depending on the gate bias. In the forward bias of the p-n junction regime, the few-layer ReS$_2$/WSe$_2$ heterostructure has a rapid current increase section only.

Figure S4. Optoelectronic properties of the few-layer ReS$_2$/WSe$_2$ heterostructure. (a) Short-circuit current ($I_{sc}$) and (b) open-circuit voltage ($V_{oc}$) with respect to the incident power of the 405-nm laser. $I_{sc}$ exhibits a linear increase, and $V_{oc}$ is saturated with incident power, as $I_{sc}$ and $V_{oc}$ are related to the illumination intensity and bandgap, respectively.
Figure S5. (a) Photovoltaic effect of the few-layer ReS$_2$/monolayer WSe$_2$ heterostructure. (b) Electrical power ($P_{el}$) with an incident laser power ($P_{in}$). (c) Fill factor with respect to $P_{in}$. All of measurement were conducted at -50 V gate bias with 405-nm laser. Although both layers have direct band gap, it exhibits low fill factor compared with few-layer ReS$_2$/WSe$_2$ heterostructure. Because this structure has very low short circuit current. Therefore, we assume that monolayer has not enough absorbing layer due to ultrathin thickness.