Supplemental Information

Figure S1. (a) The electrical characteristics ($V_{DS}$-$I_{DS}$) of the $n$-type ZnO film; and (b) the XRD pattern of the ZnO film deposited on a bare Si substrate. The $V_{DS}$-$I_{DS}$ curves indicate that the sputtered ZnO film used in this study has clear $n$-type characteristics for the $pn$ heterojunction photodiode. In addition, the crystallinity of the sputtered ZnO film is evaluated from the XRD pattern in a good agreement with the JCPDS card of ZnO (#75-1533). The good crystallinity of the sputtered ZnO film is observed from the XRD pattern in this study.

Figure S2. The magnitudes of the dark current and the photocurrent as a function of the gate voltage of the Si NWs-FET. When the gate voltage of $-9$ V is applied on the gate electrode, the magnitude of the dark current increases significantly, which is responsible for the low on/off ratio of the photodiode.