Supporting Information

Probing the Photovoltaic Properties of Ga-Doped CdS–Cu₂S

Core–Shell Heterostructured Nanowire Devices

Ming-Yen Lu\textsuperscript{a, b, *}, Meng-Hsiang Hong\textsuperscript{c}, Yen-Min Ruan\textsuperscript{c}, and Ming-Wei Lu\textsuperscript{d}

\textsuperscript{a} Department of Materials Science and Engineering, National Tsing Hua University, Hsinchu 300, Taiwan
\textsuperscript{b} High Entropy Materials Center, National Tsing Hua University, Hsinchu 300, Taiwan
\textsuperscript{c} Graduate Institute of Opto-Mechatronics, National Chung Cheng University, Chia-Yi 62102, Taiwan
\textsuperscript{d} National Nano Device Laboratories, Hsinchu 300, Taiwan

* Corresponding Author: mylu@mx.nthu.edu.tw
Figure S1 SEM images of CdS NWs grown using (a) 0.1, (b) 0.2, and (c) 0.3 g of the Ga source.

Figure S2 XRD patterns of the various samples.
Fabrication of heterostructured devices

First, a Ga-doped NW was dispersed on a pre-patterned 300-nm SiO$_2$/Si substrate [Fig. S4(a)]; after EBL and a lift-off process, 120-nm Ti and 30-nm Au were deposited as the electrode on one side of the CdS NW [Fig. S4(b)]. The NW was then immersed in 5 M CuCl in MeOH at 50 °C for 10 s to form a Cu$_2$S shell on the CdS NW, through cation exchange [Fig. S4(c)]; the heterostructured NW device was obtained after deposition of a 120-nm Ni/30-nm Au electrode on the Cu$_2$S shell [Fig. S4(d)]. Ti and Ni served as contact metals for the CdS and Cu$_2$S, respectively, forming ohmic contacts at the interfaces.
**Figure S4** Schematic representation of the fabrication process flow of a CdS–Cu$_2$S core–shell heterostructure device.

- **The definitions of fill factor (FF) and the power conversion efficiency (η)**

  The FF and the power conversion efficiency (η) are crucial parameters for gauging the performance of any solar cell; they are defined as,

  \[
  FF = \frac{J_m \times V_m}{J_{sc} \times V_{oc}} \quad (1)
  \]

  and

  \[
  \eta = \frac{J_{sc} \times V_{oc} \times FF}{P_{in}} \quad (2)
  \]

  where $J_m$ and $V_m$ are the current density and voltage, respectively, measured when the output power of the device was at its maximum value, and $P_{in}$ is the power density of the incident light.