Supplementary information

Fabrication of Large Scale Single Crystal Bismuth Telluride (Bi_2Te_3) Nanosheet Arrays by Single Step Electrolysis Process

Hung-Wei Tsai,[1]Tsang-Hsiu Wang,[1]Tsung-Cheng Chan,[1]Pei-Ju Chen,[2]Chih-Chun Chung,[1] Alireza Yaghoubi[3], Chien-Neng Liao,[1]Eric Wei-Guang Dia[2], and [1]Yu-Lun Chueh[1,4]*

[1]*Department of Materials Science and Engineering, National Tsing Hua University, Hsinchu, 30013, Taiwan*

[2] *Department of Applied Chemistry, National Chiao Tung University, Hsinchu 30010, Taiwan*

[3]Centre for High Impact Research, University of Malaya, Kuala Lumpur 50603, Malaysia.

[4]Center For Nanotechnology, Material Science, and Microsystem, *ational Tsing Hua University, Hsinchu, 30013, Taiwan*

**E-mail:ylchueh@mx.nthu.edu.tw*

Calcualtion of the bond energies of $Te^{(1)}$-Bi, $Te^{(2)}$-Bi, and $Te^{(1)}$- $Te^{(1)}$ in Bi_2Te_3 :

According to the calculation results of Kaviany and co-workers, the calculated bond energies of $Te^{(1)}$-Bi, $Te^{(2)}$-Bi, and $Te^{(1)}$- $Te^{(1)}$ in Bi_2Te_3 can be obtained as shown in below.

For $Te^{(1)}$ atom: bonds with three Bi and three $Te^{(1)}$ atoms

$$=> 3\times 0.974 + 3\times 0.0691 = 3.1293\,eV$$

For $Te^{(2)}$ atom: bonds with six Bi atoms

$$=> 6\times 0.5801 = 3.4806\,eV$$

For Bi atom: bonds with three $Te^{(1)}$ and three $Te^{(2)}$ atoms

$$=> 3\times 0.974 + 3\times 0.5801 = 4.6623\,eV$$

Existence of H_2Te gas during the electrolysis process

In order to prove the existence of H_2Te gas during the electrolysis process, we design an experiment as shown in Figure S1 (a). A Si substrate was suspended upon the electrolyte while doing the electrolysis process and the tellurium was formed by the decomposition of H_2Te gas[1]. Figure S1 (b) shows the schematics of formation of H_2Te derived Te , and the reaction process can be visualized as below:

$$H_2Te_{(g)} + \frac{1}{2}O_2 \rightarrow H_2O + Te_{(s)}$$

The H_2Te derived Te was distinguished by Raman spectrum. In the Raman spectrum of H_2Te derived Te, three peaks are located at 92.4, 121.6, and 141.1 cm^{-1}, corresponding to optical modes of E^l , A_1, and E^u, respectively[2], as shown in Figure S1(d). These three peaks are consistent with the results from pure Te ingot. The SEM image of H_2Te derived Te is shown in Figure S1(c) and reveals the blade shape.

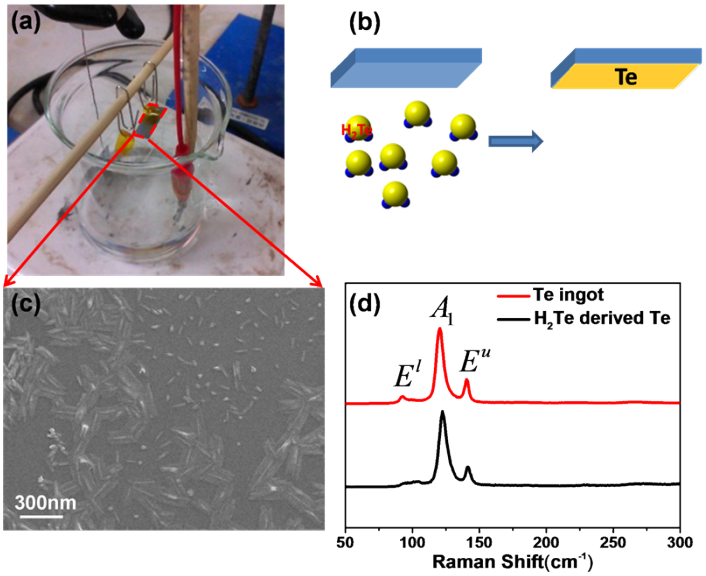

Figure S1. (a) Suspended Si substrate upon the electrolyte. (b) Schematics of H_2Te derived Te. (c) SEM image of H_2Te derived Te. (d) Raman spectrum of Te ingot and H_2Te derived Te.

REFERENCES

[1] T. Engelhard, E. D. Jones, I. Viney, Y. Mastai, G. Hodes, *Thin Solid Films* **2000**, *370*, 101-105.
[2] B. H. Torrie, *Solid State Communications* **1970**, *8*, 1899-1901.