Supporting Information

All Inorganic Semiconductor Nanowire Mesh for Artificial Photosynthesis

Bin Liu[1,4,], Cheng-Hao Wu[1,3], Jianwei Miao[4], Peidong Yang[1,2,3*]*

[1]Department of Chemistry, University of California, Berkeley, California 94720, USA

[2]Department of Materials Science and Engineering, University of California, Berkeley, California 94720, USA

[3]Materials Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, California 94720, USA

[4]School of Chemical and Biomedical Engineering, Nanyang Technological University, Singapore 637459, Singapore

Email: liubin@ntu.edu.sg (B. Liu) and p_yang@berkeley.edu (P. D. Yang)

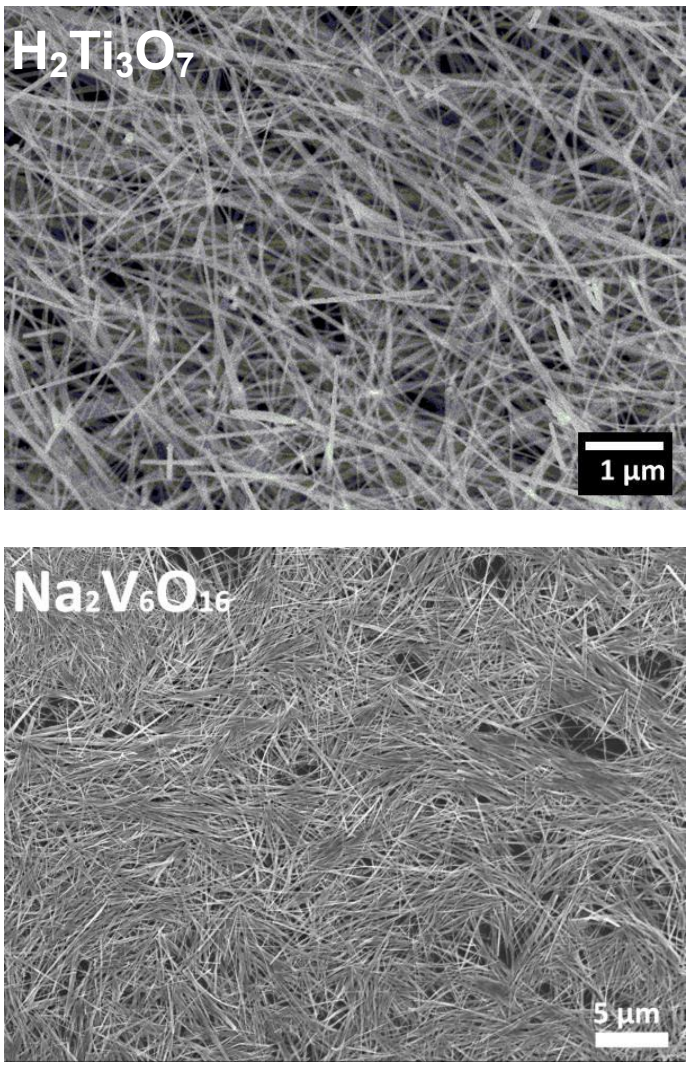

Figure SI-1. FESEM images of $H_2Ti_3O_7$ nanowires and $Na_2V_6O_{16}\cdot 3H_2O$ nanowires.

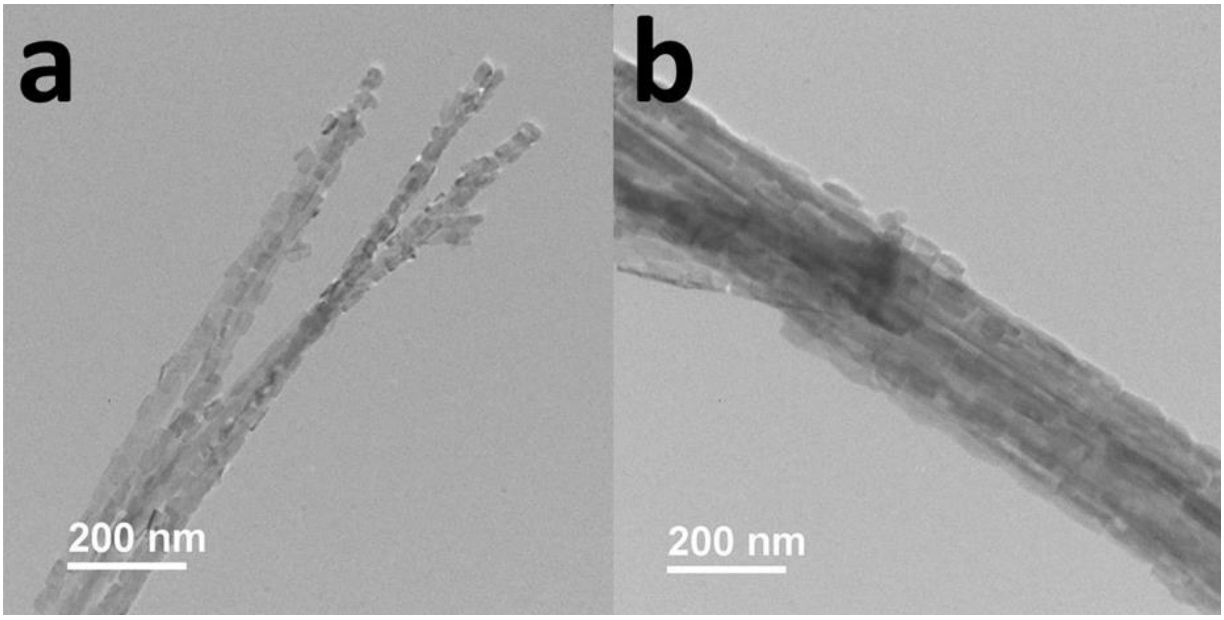

Figure SI-2. TEM images of $BiVO_4$ nanowires.

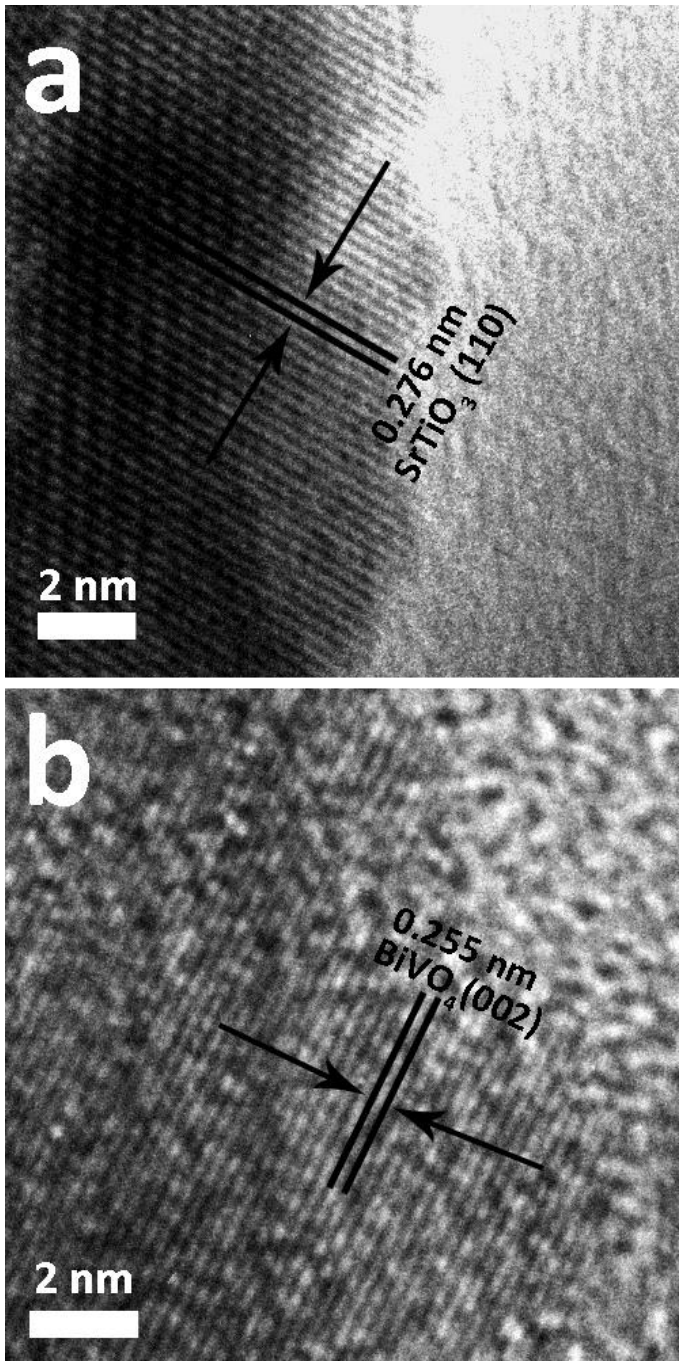

Figure SI-3. HRTEM images of (a) Rh-$SrTiO_3$ nanowires and (b) $BiVO_4$ nanowires.

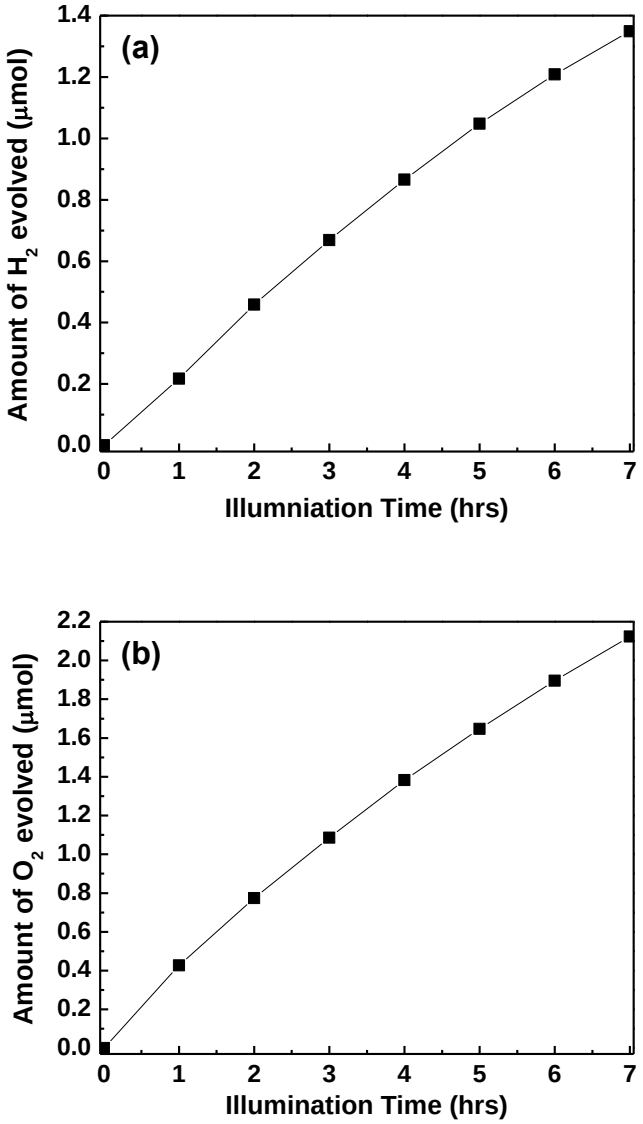

Figure SI-4. (a) H_2 evolution from 2 mg of Rh-$SrTiO_3$ nanowires loaded with 1 wt % of Ru in 3 ml water-methanol solution under visible light irradiation, and (b) O_2 evolution from 2 mg of $BiVO_4$ nanowires in 3 ml $Fe_2(SO_4)_3$ aqueous solution under visible light irradiation.

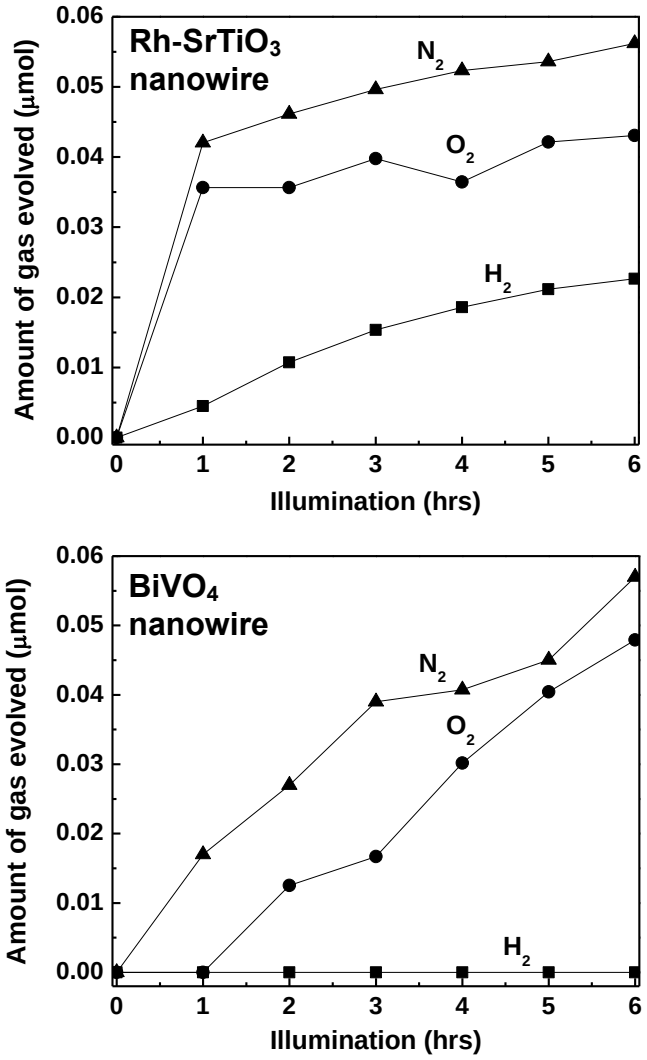

Figure SI-5. H_2 and O_2 evolution from Rh-$SrTiO_3$ and $BiVO_4$ nanowires in 3 ml of water at pH = 3.5 (adjusted using dilute H_2SO_4) under visible light irradiation. The photocatalyst amount was 15 mg. Note: the faster O_2 evolution rate as compared with H_2 evolution rate is due to O_2 leakage from ambient air.

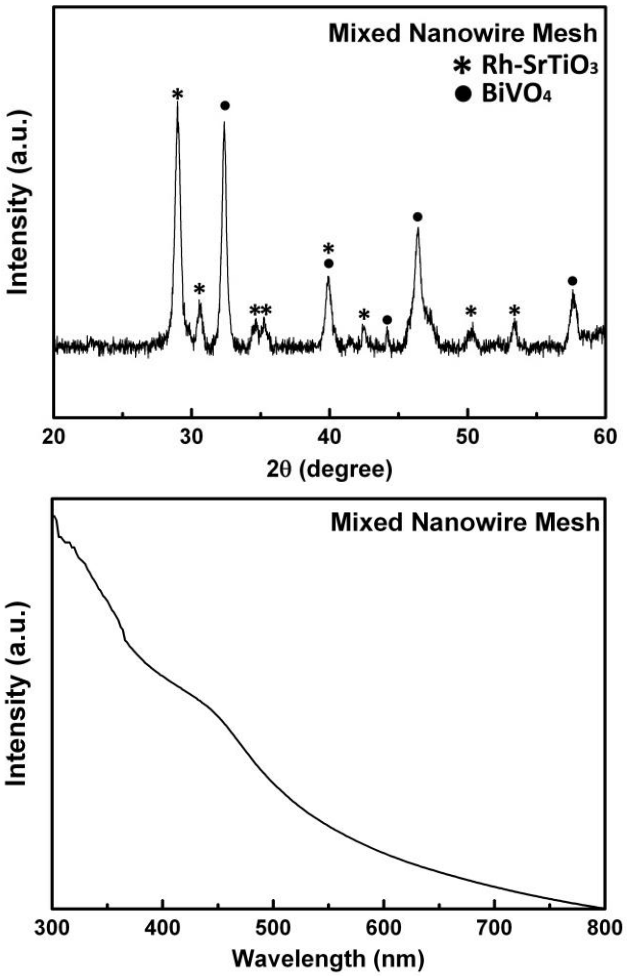

Figure SI-6. (a) XRD pattern and (b) UV-vis spectrum of mixed Rh-$SrTiO_3$ and $BiVO_4$ nanowire mesh film.

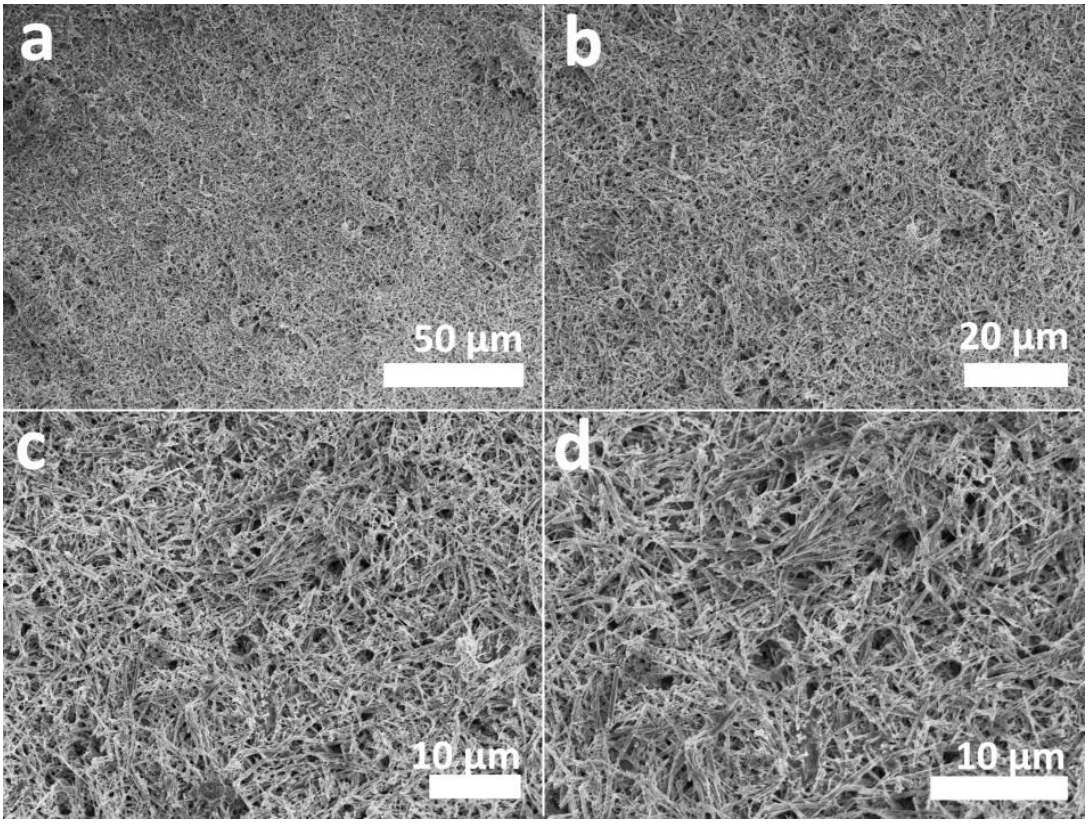

Figure SI-7. FESEM images of mixed Rh-$SrTiO_3$ and $BiVO_4$ nanowire mesh film.

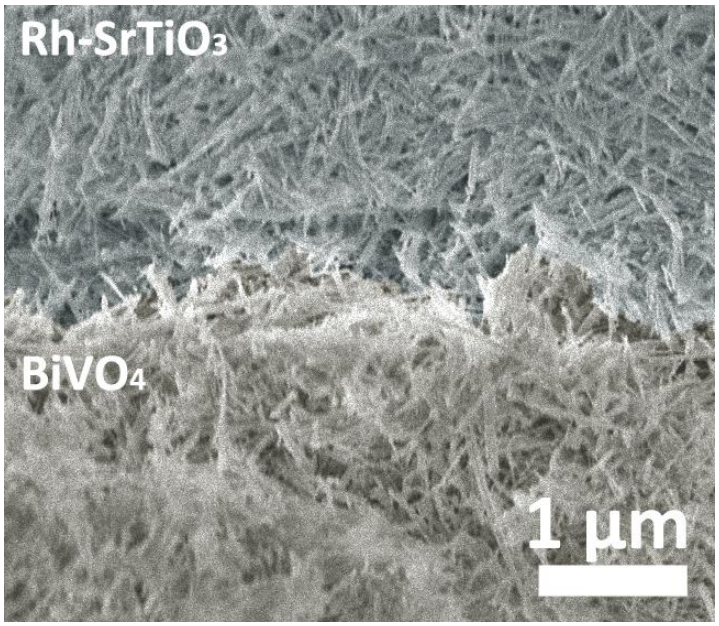

Figure SI-8. Cross-sectional FESEM image to show the interface of the Rh-$SrTiO_3$ and $BiVO_4$ bilayer nanowire mesh.

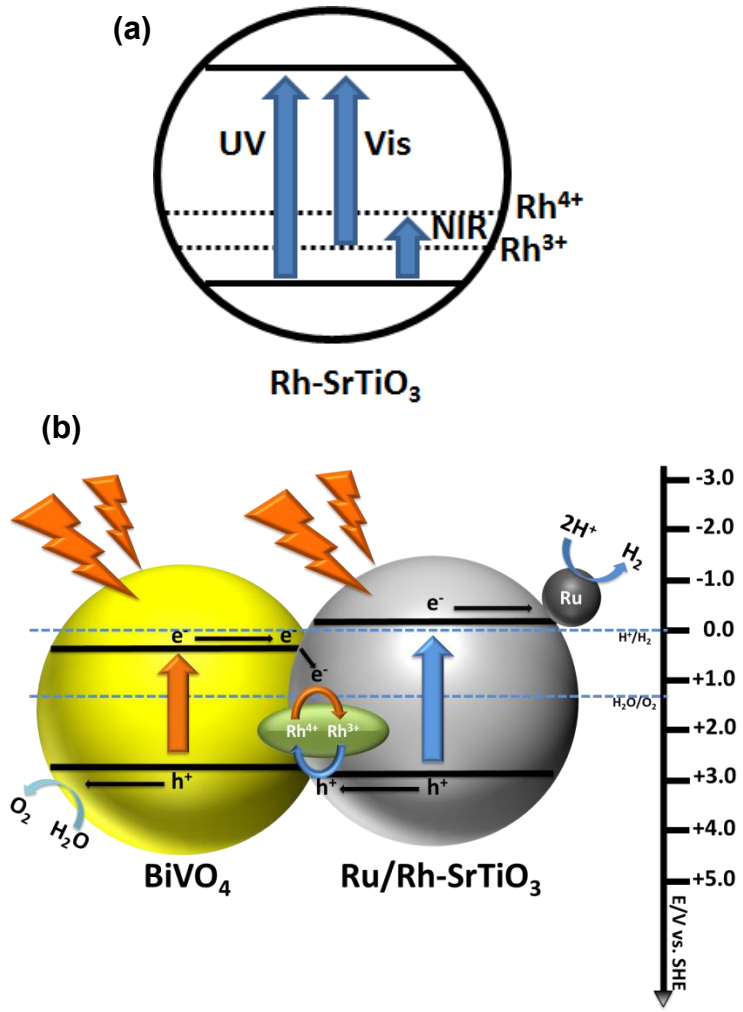

Figure SI-9. (a) Proposed band structure and visible light response of Rh-$SrTiO_3$ nanowires. (b) Scheme of photocatalytic overall water splitting based on Ru/Rh-$SrTiO_3$ and $BiVO_4$ nanowire system.[1-4]

References:

1. Konta, R.; Ishii, T.; Kato, H. & Kudo, A. *J. Phys. Chem. B* **108**, 8992-8995 (2004).
2. Sasaki, Y.; Nemoto, H.; Saito, K. & Kudo, A. *J. Phys. Chem. C* **113**, 17536-17542 (2004).
3. Iwase, A.; Ng, Y. H.; Ishiguro, Y.; Kudo, A. & Amal, R. *J. Am. Chem. Soc.* **133**, 11054-11057 (2011).
4. Jia, Q.; Iwashina, K. & Kudo, A. *Proc. Natl. Acad. Sci. USA* **109**, 11564-11569 (2012).

Note: The photoactivity of the nanostructured Rh-$SrTiO_3$ and $BiVO_4$ nanowire film is about one order of magnitude lower than that of the previously reported powder mixtures (reference: J. Phys. Chem. C 2009, 113, 17536-17542. J. Am. Chem. Soc. 2011, 133, 11054-11057). The possible reasons for this observed lower photoactivity of our nanostructured Rh-$SrTiO_3$ and $BiVO_4$ nanowire film can be explained as the following: 1. The dispersed powder mixtures have better light absorption efficiency than the compact nanowire mesh film. 2. The previously reported experiment was carried out at low pressure (40 Torr) and our experiment was done at atmospheric pressure (~ 800 Torr). 3. The gas evolution and reactant diffusion could be a problem in our compact nanowire mesh film. 4. The illumination method used in our experiment was different from the previously reported method, which might affect the light absorption efficiency in our experiment. 5. The crystal quality of our Rh-$SrTiO_3$ and $BiVO_4$ nanowires prepared using the ion-exchange method as compared with the Rh-$SrTiO_3$ and $BiVO_4$ powders prepared using high-temperature sintering method may affect the photoactivity.