Supporting Information

Pt nanoparticles-decorated two-dimensinal oxygen-deficient TiO_2 nanosheet as an efficient and stable electrocatalyst for hydrogen evolution reaction

Keerti M. Naik*, Eiji Higuchi, Hiroshi Inoue*

Department of Applied Chemistry, Graduate School of Engineering, Osaka Prefecture University, Sakai, Osaka 599-8531, Japan

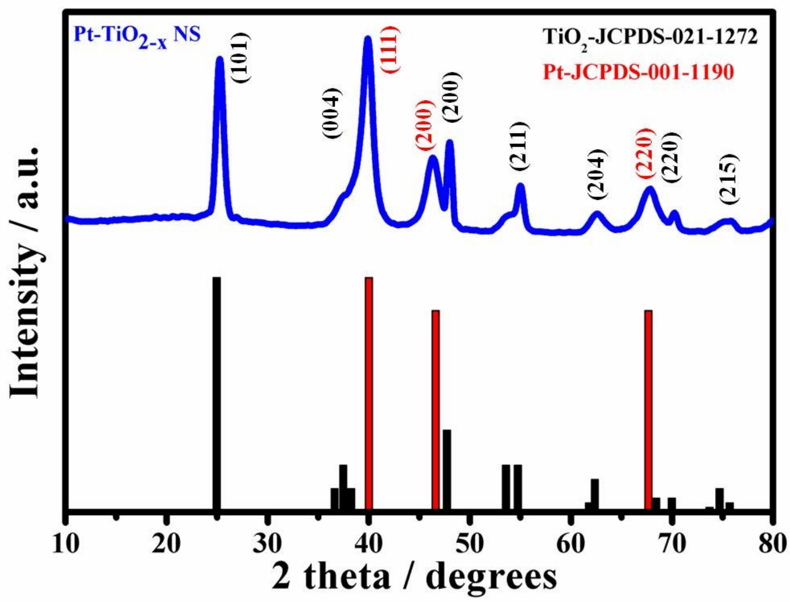

Fig. S1. (a) XRD pattern of Pt-TiO_{2-x}NSs compared with standard patterns.

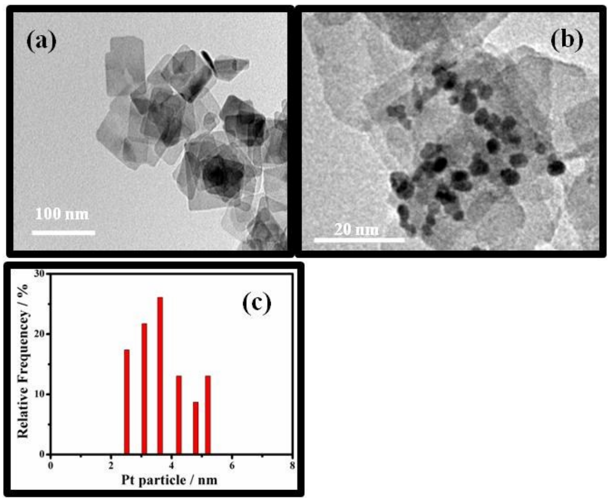

Fig. S2. TEM images of (a) TiO_2 NSs, (b) Pt-TiO_2 NSs and (c) particle size distribution profile of Pt-TiO_2 NSs.

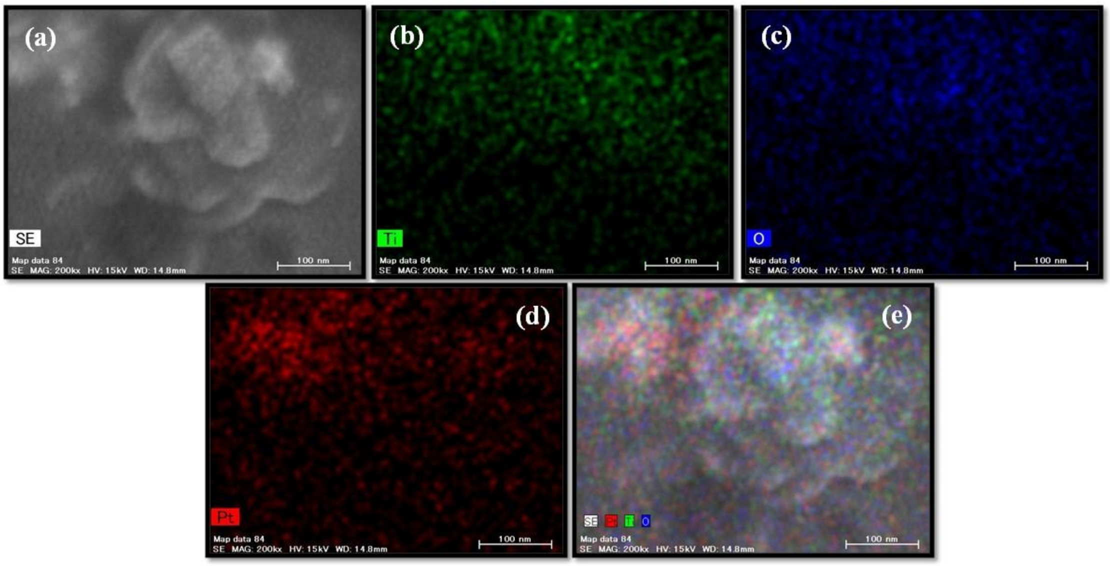

Fig. S3. (a) SEM images and elemental maps of (b) Ti, (c) O, (d) Pt and (e) their superposition for Pt-TiO_{2-x} NSs.

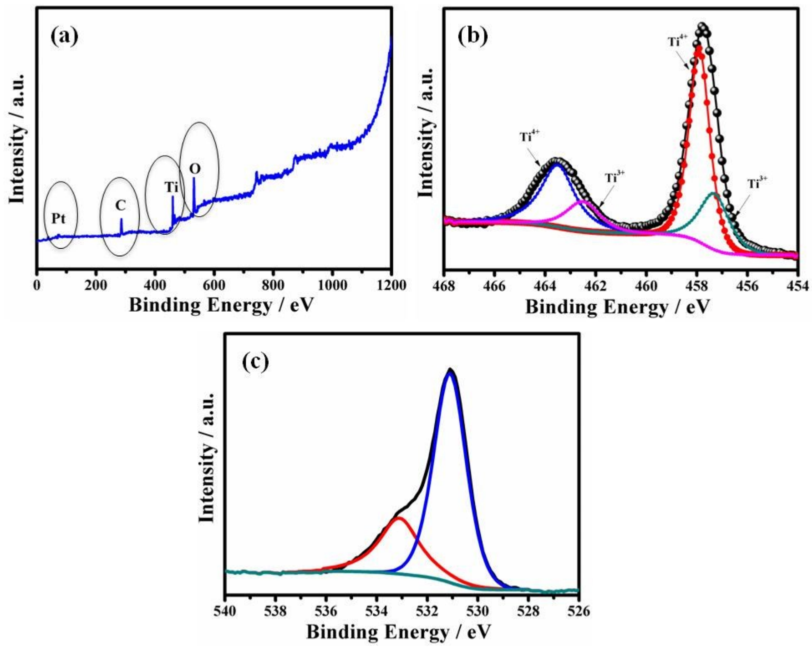

Fig. S4. (a) Wide scan spectra of Pt-TiO_{2-x} NSs (C is the carbon observed from the substrate i.e, carbon tap), the corresponding high resolution (b) Ti 2p and (c) O 1s spectra.

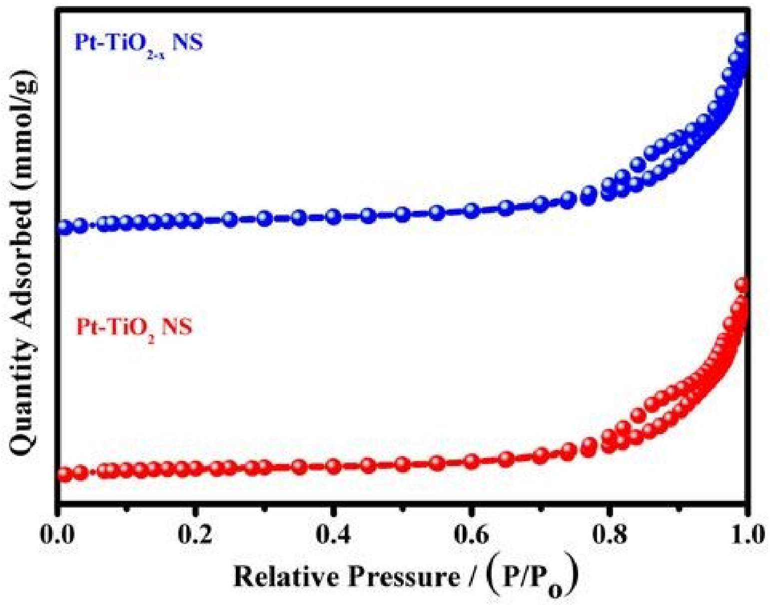

Fig. S5. Nitrogen adsorption-desorption isotherms of Pt-TiO_2 NSs and Pt-TiO_{2-x} NSs.

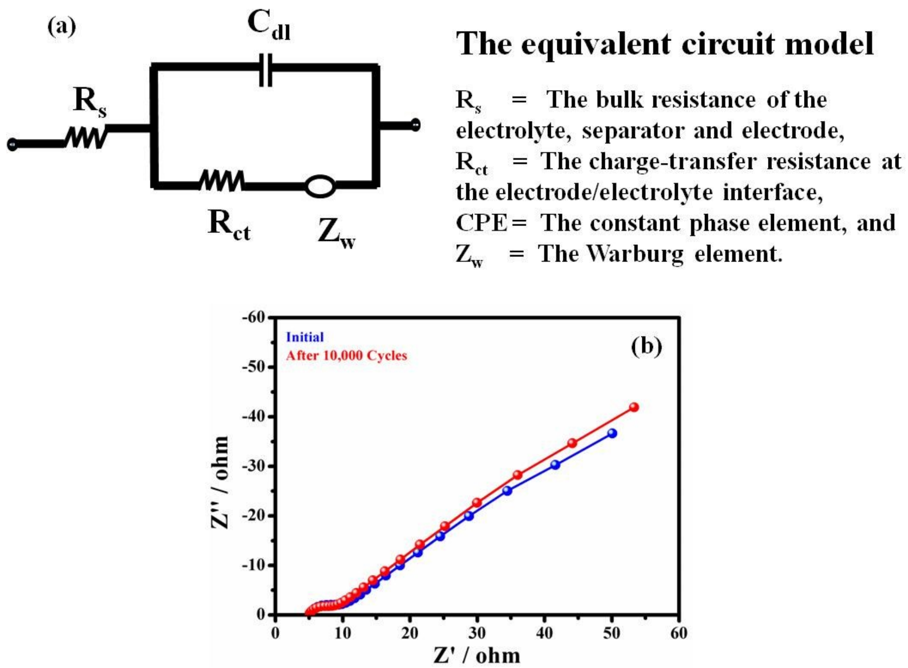

Fig. S6. (a) The equivalent circuit used to fit the experimental data from Nyquist plots and (b) Nyquist plots of Pt-TiO_{2-x} NSs before and after stability experiment.

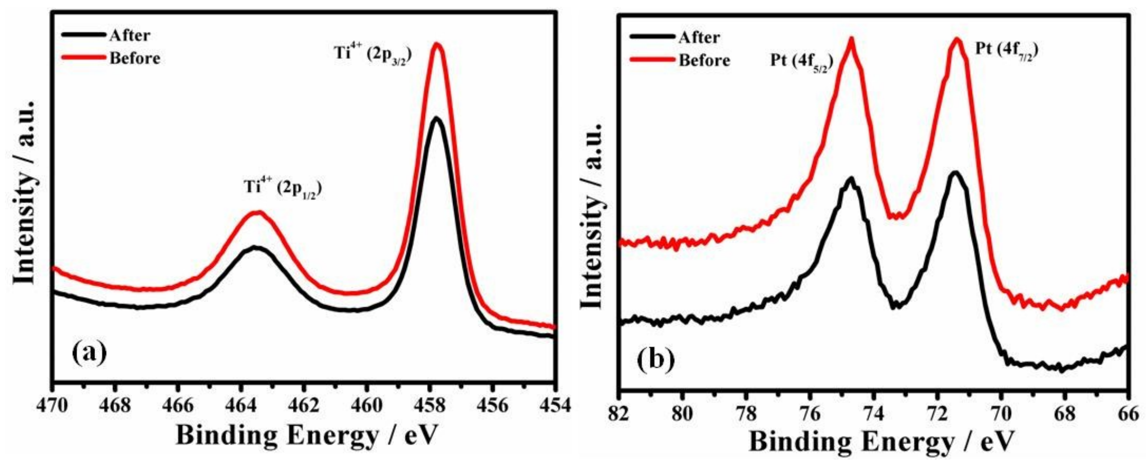

Fig. S7. XPS spectra of (a) Ti 2p and (b) Pt 4f of Pt-TiO_{2-x} NSs before and after stability experiment.

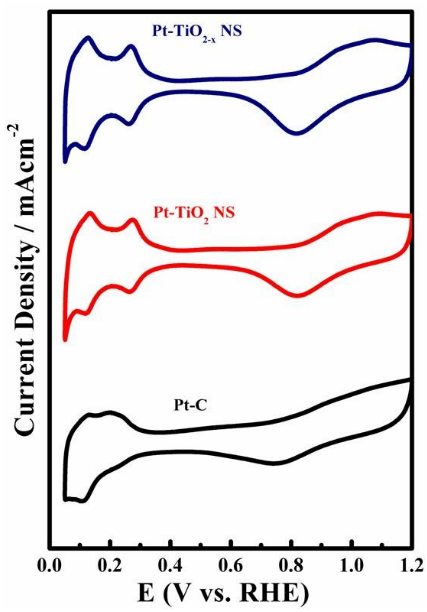

Fig. S8. Cyclic voltammograms of Pt-TiO_{2-x} NSs, Pt-TiO_2NSs and Pt/C in Ar-saturated 0.5 M H_2SO_4 solution.

Table S1: Comparison of HER performance in 0.5 M H_2SO_4/1.0 M KOH/1.0 M PBS solutionofPt-TiO_{2-x} NSs with other reported Pt supported electrocatalyst.

Catalyst	Electrolyte	Overpotential @10 mA/cm^2 (mV)	Tafel slope	Stability	Reference
Pt/def-WO_3@CFC	0.5 M H_2SO_4	42	61	-	1
Pt/NPC	0.5 M H_2SO_4	15	36.3	35 h (8 mV)	2
Pt@NHPCP	0.1 M $HClO_4$	57	27	-	3
Pt NWs/SL-Ni(OH)	1M KOH	67.8	-	-	4
Pt NPs/SL-Ni(OH)	1M KOH	85.2	-	-	4
Pt/Ni	0.5 M H_2SO_4	36	43	5.5 h (50 mV)	5
$GaPt_3$	0.5 M H_2SO_4	27	43.3	48 h (300 mV)	6
	1.0 M KOH	48	63.1		
	1.0 M PBS	103	85.3		
Pt SA/WO_{3-x}	0.5 M H_2SO_4	47	45	-	7
$Pt_1/MoO_{3-x}/C$	0.5 M H_2SO_4	23.3	28.8	-	8
Pt-MoS_2	0.1 M H_2SO_4	144	96	-	9
Pt-GDY	0.5 M H_2SO_4	66	46.6	2.7 h (95 mV)	10
Pt/WS_2	0.5 M H_2SO_4	80	55	-	11
Pt@PCM	0.5 M H_2SO_4	105	65.3	5 h (150 mV)	12
	1.0 M KOH	150	73.6		
Pt- MoS_2/NiS_2	0.5 M H_2SO_4	52	40	72 h (10,20,50 mAcm^{-2})	13
Pt-TiO_{2-x} NSs	0.5 M H_2SO_4	36	32.1	50 h (50 mV)	Present work
	1.0 M KOH	69	50.2		
	1.0 M PBS	87	67.6		

References

1 H. Tian, X. Cui, L. Zeng,L.Su, Y. Song and J. Shi, *J. Mater. Chem. A,* 2019, **7**, 6285-6293.

2 C.H. Wang, F. Hu, H.C. Yang, Y.J. Zhang, H. Lu and Q.B. Wang, *Nano Res.,* 2017, **10**, 238-246.

3 J. Ying, G.P. Jiang, Z.P. Cano, L. Han, X.Y. Yangand , Z.W. Chen, *Nano Energy,* 2017, **40**, 88-94.

4 H.J. Yin, S.L. Zhao, K. Zhao, A. Muqsit, H.J. Tang, L. Chang, H.J. Zhao, Y. Gao and Z.Y. Tang, *Nat. Commun.,* 2015, **6**, 6430.

5 M.S. Xiao, R. Cheng, M.F. Hao, M. Zhou and Y.Q. Miao, *ACS Appl. Mater. Inter.,* 2015, **7**, 26101-26107.

6 S.C. Lim, C.Y. Chan, K.T. Chen and H.Y. Tuan, *Electrochimica Acta,* 2019, **297**, 288-296.

7 J. Park,S. Lee,H.E. Kim,A. Cho,S. Kim,Y. Ye,J.W. Han, H. Lee,J.H. Jang and J. Lee, *Angew. Chem. Int. Ed.,* 2019, **58**, 16038-16042.

8 W. Liu, Q. Xu, P. Yan, J. Chen, Y. Du, S. Chu and J. Wang, *ChemCatChem,*2018, **10**, 946-950.

9 J. Deng, H. Li, J. Xiao, Y. Tu, D. Deng, H. Yang, H. Tian, J. Li, P. Ren and X. Bao, *Energy Environ. Sci.,* 2015, **8**, 1594-1601.

10 X.P. Yin, H.J. Wang, S.F. Tang, X. L. Lu, M. Shu, R. Si and T.B. Lu, *Angew. Chem. Int. Ed.,* 2018, **57**, 9382-9386.

11 Y. Zhang, J. Yan, X. Ren, L. Pang, H. Chen and S. Liu, *International Journal of hydrogen Energy,* 2017, **42**, 5472-5477.

12 H. Zhang, P. An, W. Zhou, B.Y. Guan, P. Zhang, J. Dong and X.W. Lou, *Sci. Adv.,* 2018, **4**,6657.

13 Y. Guan, Y. Feng, J. Wan, X. Yang, L. Fang, X. Gu, R. Liu, Z. Huang, J. Li, J. Luo, C. Li and Y. Wang, *Small,* 2018, **14**, 1800697.