

Supporting information for

Controlled Synthesis of Pt Nanoparticle supported TiO₂ Nanorods as efficient and stable electrocatalyst for Oxygen Reduction Reaction

*Paskalis Sahaya Murphin Kumar,^{a,b,c} Vinoth Kumar Ponnusamy,^c Deepthi Koolath Ramakrishnan,^d Gopalakrishnan kumar,^e Arivalagan Pugazhendhi,^f Hideki Abe,^a Sivakumar Thiripuranthagan,^{*b} Umapada pal,^g and Siva Kumar Krishnan^{*h}*

^a*National Institute for Materials Science (NIMS), 1-1 Namiki, Ibaraki Tsukuba, 305-0044 Japan.*

^b*Department of Applied Science and Technology, Anna University, Chennai, Tamil Nadu 600-025, India.*

^c*Research Centre for Environmental Medicine, Kaohsiung Medical University, Kaohsiung City, Taiwan*

^d*Department of Medicinal and Applied Chemistry, Kaohsiung Medical University, Kaohsiung City, Taiwan*

^e*Institute of Chemistry, Bioscience and Environmental Engineering, Faculty of Science and Technology, University of Stavanger, Box 8600 Forus, 4036 Stavanger, Norway.*

^f*Faculty of Environment and Labour Safety, Ton Duc Thang University, Ho Chi Minh City 756600, Vietnam*

^g*Instituto de Física, Benemérita Universidad Autónoma de Puebla, Apdo. Postal J-48, Puebla 72570, México.*

^h*CONACYT- Instituto de Física, Benemérita Universidad Autónoma de Puebla, Apdo. Postal J-48, Puebla 72570, México.*

Corresponding authors:

Siva Kumar Krishnan (sivakumar@ifuap.buap.mx)

Sivakumar Thiripuranthagan (sivakumar@annauniv.edu)

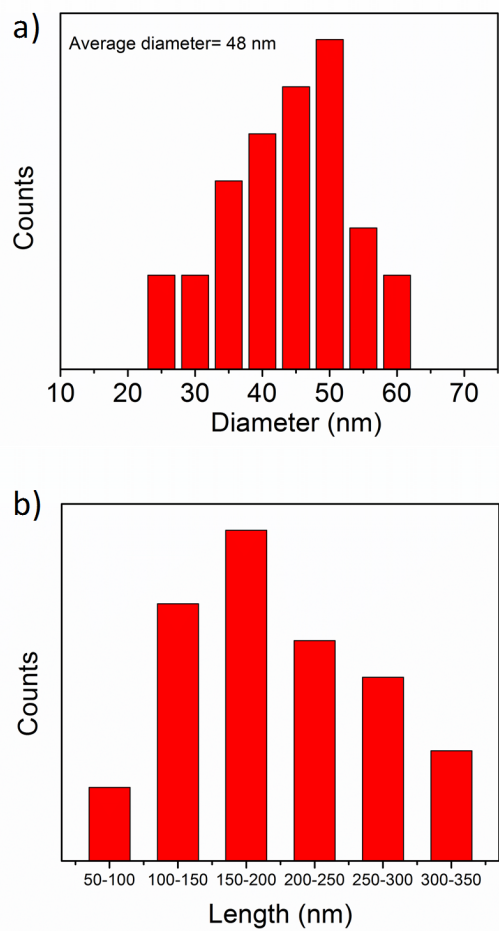


Figure S1. Size-distribution histogram of pristine TiO₂ NRs. (a) diameter, and (b) length of the TiO₂ NRs.

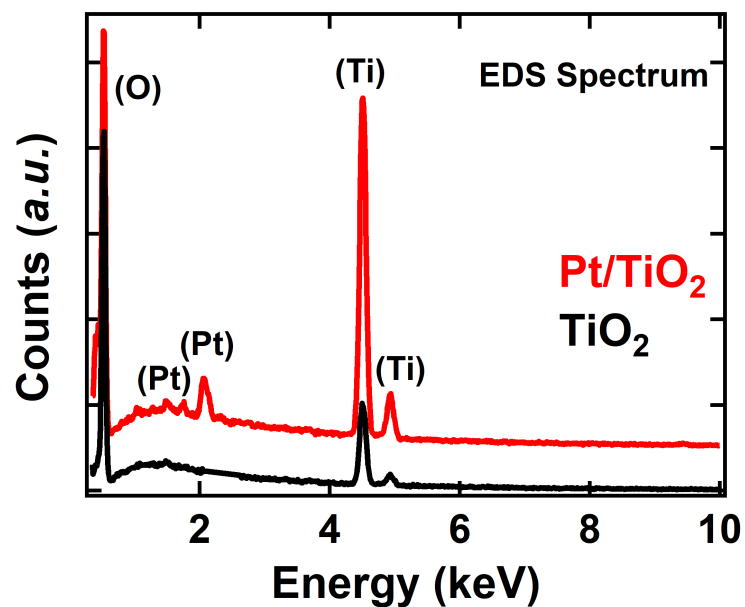


Figure S2. Representative energy-dispersion spectra (EDS) of the TiO₂NRs, and Pt/TiO₂ NRs samples.

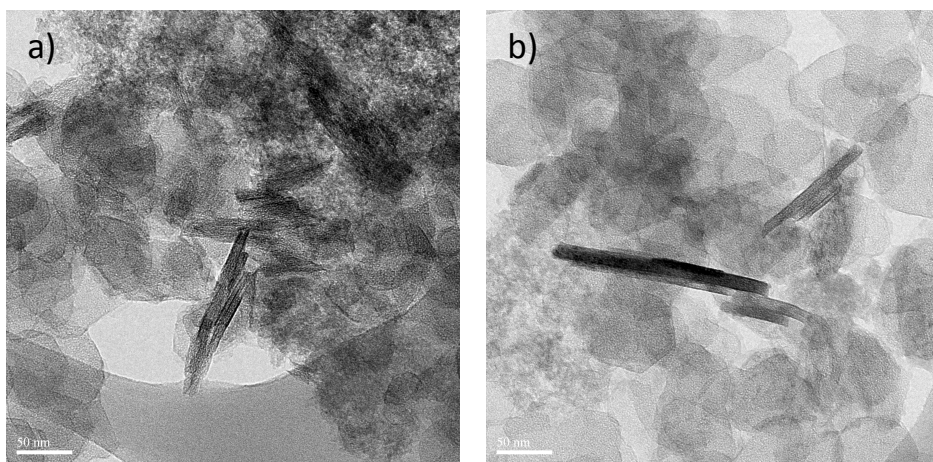


Figure S3. Low (a) and high (b)-magnification TEM images of the Pt/TiO₂ NRs supported on vulcan carbon.

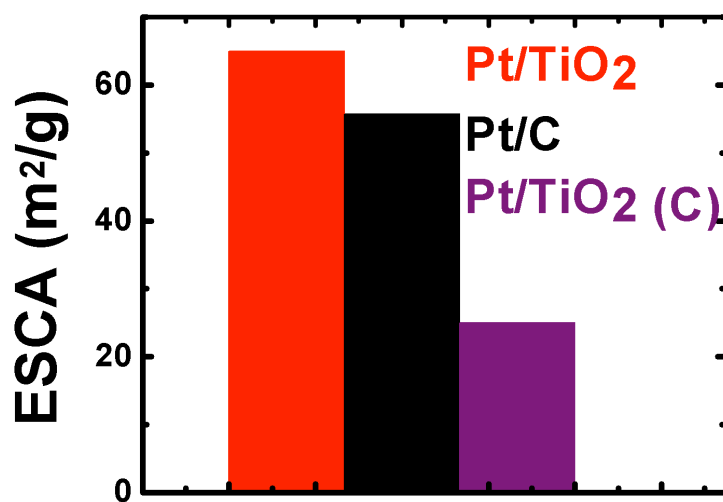


Figure S4. Summary of electrochemically active surface area (ECSA) of the Pt/TiO₂NRs, Pt/Comm. TiO₂, and commercial Pt/C catalysts.

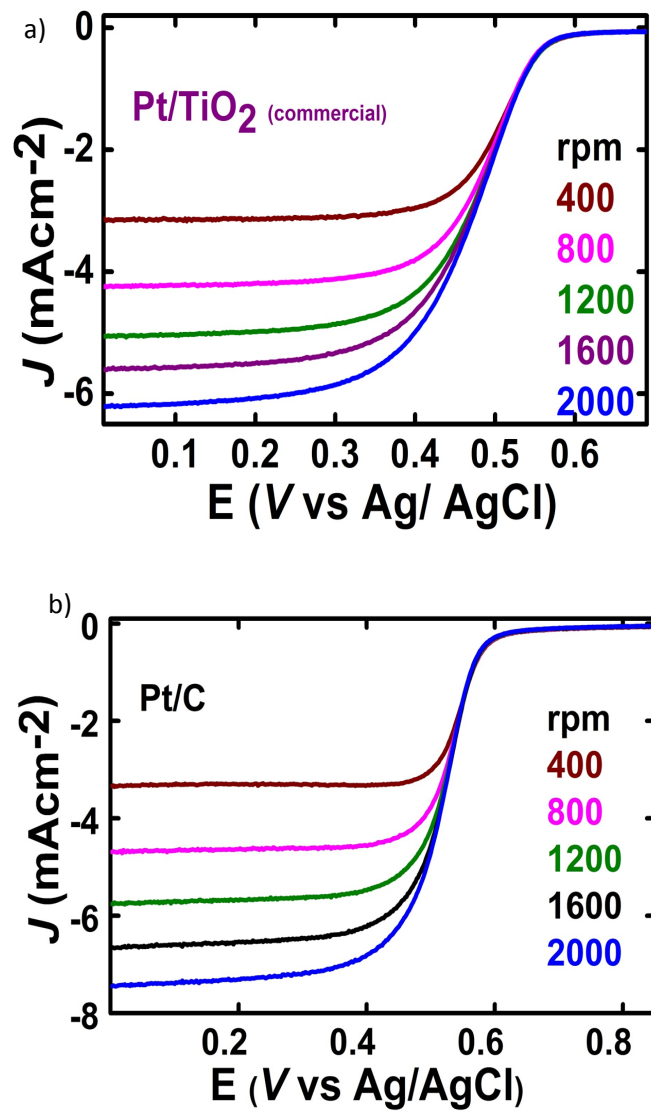


Figure S5. ORR polarization curves for the (a) Pt/ Comm TiO₂, and (b) Pt/C catalysts in O₂-saturated 0.1 M HClO₄ solution at different rotational speeds.

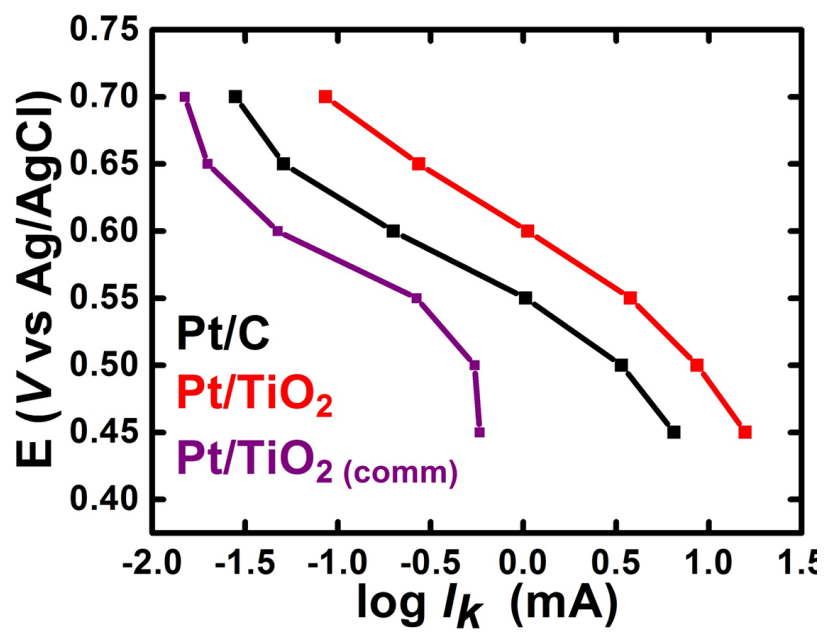


Figure S6. Tafel plots for the Pt/TiO₂NRs, Pt/Comm TiO₂, and Pt/C catalysts.

Table S1: Comparison of electrocatalytic parameters of the PtNPs/TiO₂ NRs catalysts with the previous reports of various electrocatalytic hybrid nanostructures.

Catalysts	ECSA (m ² /g _{Pt})	Tafel slope value mV dec ⁻¹	Specific activity (mA/cm ² at 0.55 V vs Ag/AgCl)	Mass activity (mA/g _{Pt})	Specific activity (mA/cm ² at 0.9 V vs RHE)	Mass activity (mA/mg _{Pt})	Reference
Pt/TiO ₂ NRs	64.95	90.5	0.428	128	13.27	6.2	this work
Pt/TiO ₂ (Comm)	23.5	92.2	0.198	99.76	6.4	1.08	this work
Pt/TiO ₂	17	NA	0.33	5.4	--	--	1
Pt@CN _x /CNT	74.29	NA	0.150	0.111	--	--	2
PtNPs/NaSb ₃ O ₇	55.8	60	1.40	195	--	--	3
Pt/TiO ₂ NPs	NA	65	NA	NA	--	--	4
PtNPs/TiO ₂	14.17	--	--	--	0.0129	1.83	5
PdPt/TiO ₂	51.2	--	--	--	3.05	--	6

NA: Not available

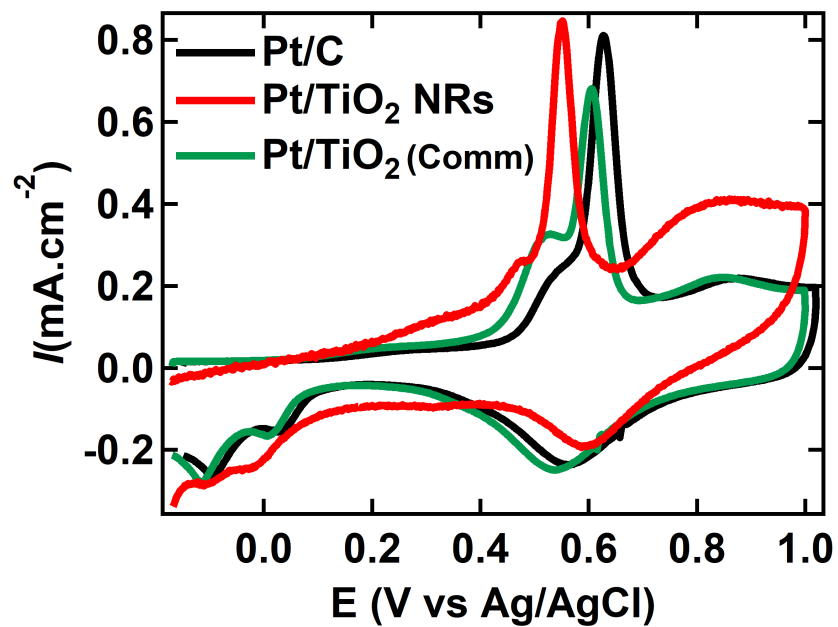


Figure S7. Comparison of CO-stripping voltammetry curves of Pt/TiO₂NRs, Pt/TiO₂(Comm), and Pt/C catalysts, obtained in 0.5 M H₂SO₄ aqueous solution at a sweep rate of 20 mV s⁻¹.

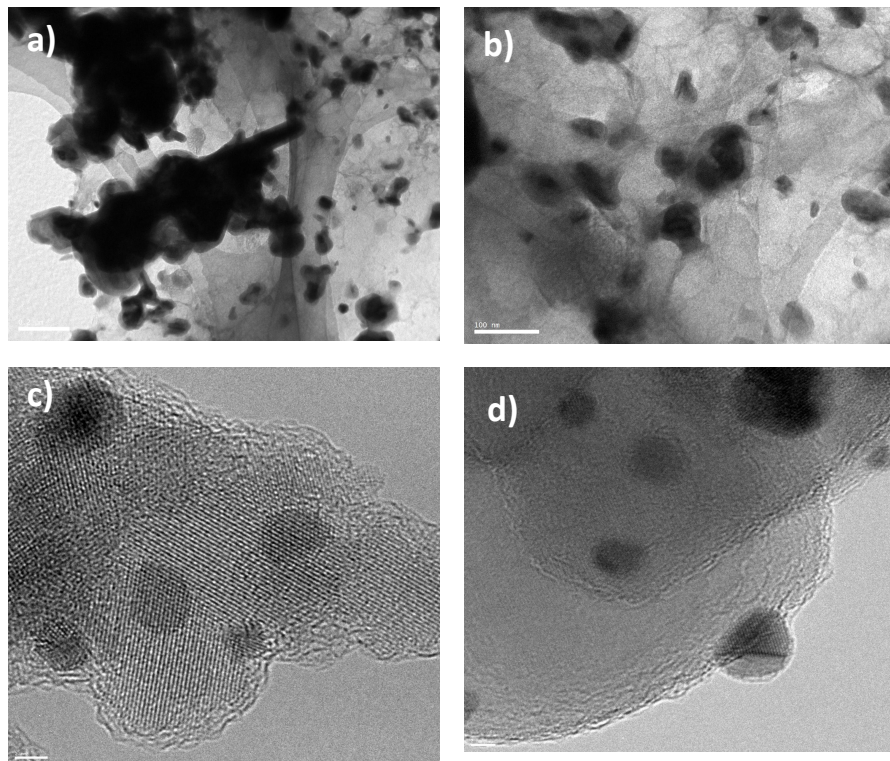


Figure S8. Typical TEM images of the Pt/C, and Pt/TiO₂NRs catalysts after ADT.

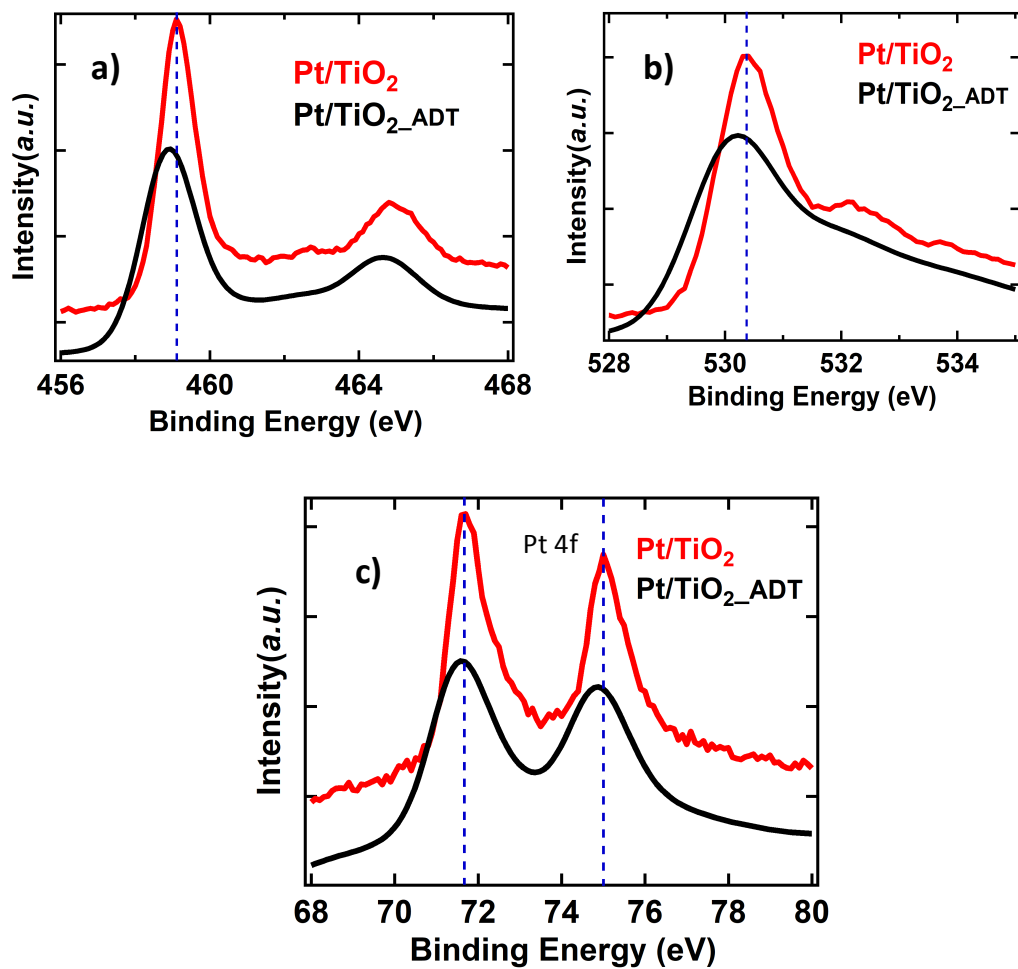


Figure S9. XPS spectra of Pt/TiO₂ NRs composite after ADT. a) Ti 2p, b) O 1s, and Pt 4f regions.

References

- 1 A. Zana, C. Rüdiger, J. Kunze-Liebhäuser, G. Granozzi, N. E. A. Reeler, T. Vosch, J. J. K. Kirkensgaard and M. Arenz, *Electrochim. Acta*, 2014, **139**, 21–28.
- 2 L. Guo, W. J. Jiang, Y. Zhang, J. S. Hu, Z. D. Wei and L. J. Wan, *ACS Catal.*, 2015, **5**, 2903–2909.
- 3 K. R. Deepthi, G. V. Ramesh, R. Kodiyath, P. S. Murphin Kumar, A. Dakshanamoorthy and H. Abe, *J. Mater. Chem. A*, 2017, **5**, 1667–1671.
- 4 J. Li, H. Zhou, H. Zhuo, Z. Wei, G. Zhuang, X. Zhong, S. Deng, X. Li and J. Wang, *J. Mater. Chem. A*, 2018, **6**, 2264–2272.
- 5 B. J. Hsieh, M. C. Tsai, C. J. Pan, W. N. Su, J. Rick, H. L. Chou, J. F. Lee and B. J. Hwang, *Electrochim. Acta*, 2017, **224**, 452–459.
- 6 S. -Y. Huang, P. Ganesan and B. N. Popov, *ACS Catal.*, 2012, **2**, 825–831.