Supplementary Information

Electrochemical reduction induced self-doping of Ti$^{3+}$ for efficient water splitting performance on TiO$_2$ based photoelectrodes

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Fig. S1 SEM images of the TiO$_2$ NTs of (a) top view, and (b) cross-sectional view.
**Fig. S2** Cross-sectional SEM image of the ECR-TiO$_2$ NTs.

**Fig. S3** XRD patterns of the TiO$_2$ NTs and ECR-TiO$_2$ NTs in magnification view in range of 20-30°.
Fig. S4 Schematics of band energy level of Ti$^{2+}$ self-doped ECR-TiO$_2$ NTs.
Fig. S5 XPS survey of the TiO$_2$ NTs and ECR-TiO$_2$ NTs.

Fig. S6 XPS core level of Ti 2p$_{3/2}$ of the TiO$_2$ NTs and ECR-TiO$_2$ NTs in the absence of argon sputtering.
Fig. S7 Na KLL Auger spectra from TiO$_2$ NTs and ECR-TiO$_2$ NTs.
**Fig. S8** PEC performance of the ECR-TiO$_2$ NT photoelectrodes reduced with different reduction potential, where x in ECR-(x)-TiO$_2$ NTs was the value of the applied potential (V). (a) linear-sweep voltammograms, collected with a scan rate of 5 mV s$^{-1}$ under simulated solar light (AM 1.5G); (b) photoconversion efficiency as a function of applied potential (calculated using equation 1); (c) summarized photocurrent density and photoconversion efficiency data.
**Fig. S9** PEC performance of the ECR-TiO$_2$ NTs photoelectrodes reduced with different duration length. (a) linear-sweep voltammograms, collected with a scan rate of 5 mV s$^{-1}$ under simulated solar light (AM 1.5G); (b) photoconversion efficiency as a function of applied potential (calculated using equation 1); (c) summarized photocurrent density and photoconversion efficiency data.
**Fig. S10** SEM image of the TiO$_2$ film on indium tin oxide (ITO) prepared from commercial P25 TiO$_2$ nanoparticles.

**Fig. S11** PEC performance of the P25 TiO$_2$ film and ECR-P25 TiO$_2$ film photoelectrodes, prepared on indium tin oxide (ITO) with commercial P25 TiO$_2$ nanoparticles.