Supporting information

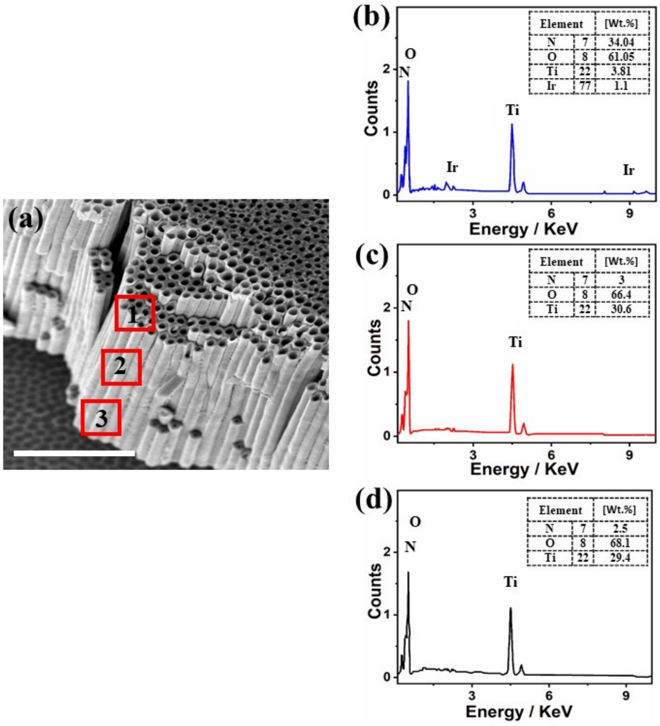

Figure S1.(a) SEM image of typically synthesized Ir/TiON-NTs NTs and its corelated EDX analsyis (b-d) at diffrent numbered areas (1-3) in (a), respetcevlly. The indcated scale bar in (a) is 1 μm.

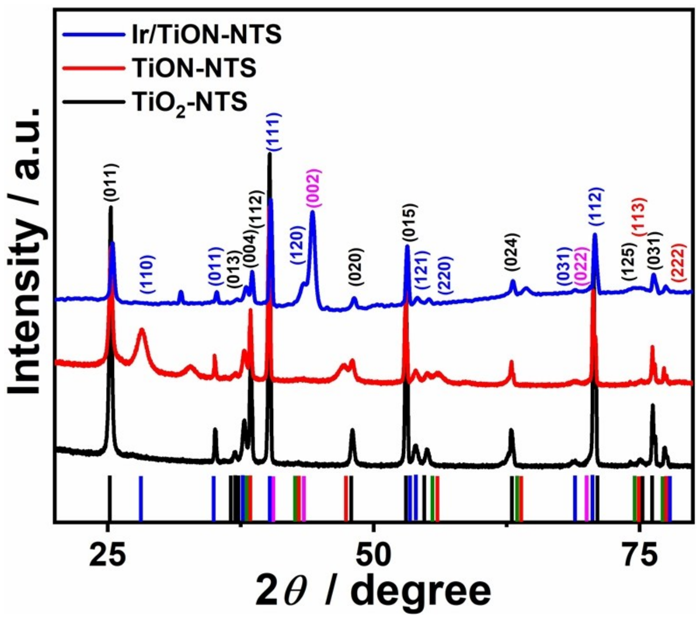

Figure S2. The wide-angle XRD diffraction patterns of typically synthesized NTs. The indicated lines at the bottom were taken from ICSD database. This is including black lines for anatase (ICSD:172914) , blue lines for rutile (ICSD:33838), green lines for TiN (ICSD:236801) and red lines for TiON (ICSD:426340), and magenta lines for Iridium nanoparticles (ICSD:426948).

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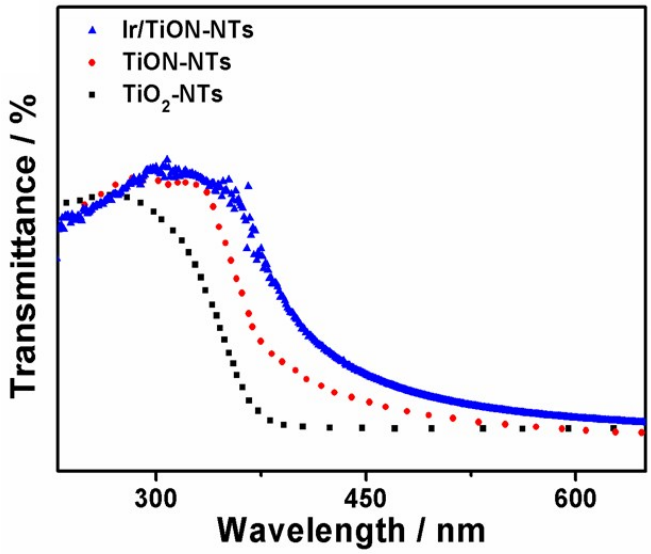

Figure S3. UV–Vis diffuse reflectance spectroscopy measurements of the as-formed materials

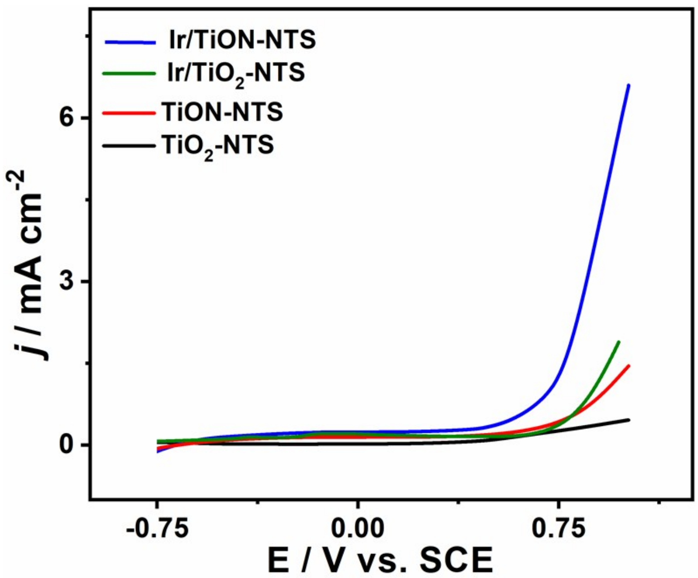

Figure S4. LSV meausred on the typically prepared materials benchmarked in an aqueous solution of 0.1 M KOH at a scan rate of 10 mV s^{-1} at room temperature under dark.

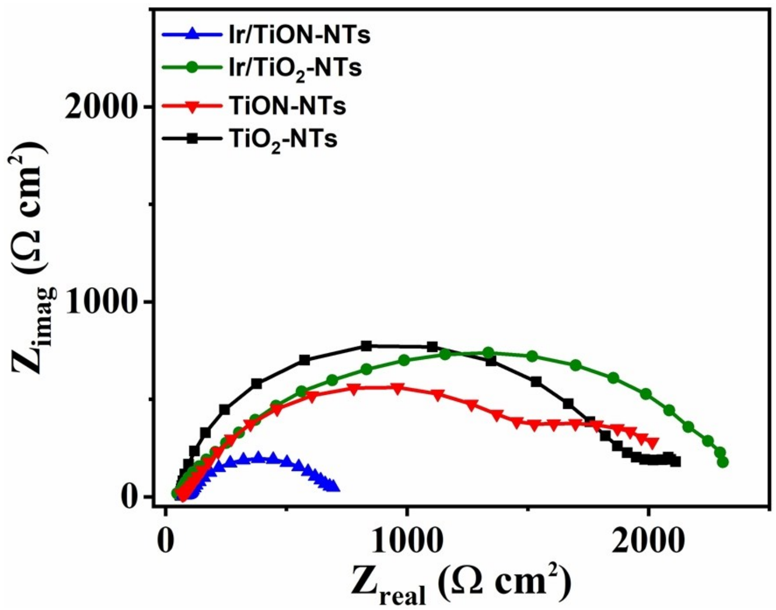

Figure S5. EIS meausred on the typically prepared materials benchmarked in an aqueous solution of 0.1 M KOH in a frequency range from 100 kHz to 5 Hz with an AC voltage amplitude of 0.8 V room temperature under light.

Mott-Schottky analysis

The Mott-Schottky analysis plot of the as-made materials was measured at 100 Hz in the potential range ranged from -1 V to +0.5 V. The charge distribution at the protective layer/electrolyte is usually determined based on Mott-Schottky relationship by measuring electrode capacitance *C*, as a function of electrode potential *E*, and assuming that the contribution of the double layer capacitance and the presence of surface states can be neglected

$$C^{-2} = \frac{2}{e\varepsilon\varepsilon_o N_d}(E - E_{Fb} - \frac{K_b T}{e})$$

(1)

where *e* is the electron charge (1.60 × 10^{-19} coulombs), *ε* is the dielectric constant, ε_0 the permittivity of vacuum (8.854 × 10^{-12} F/m), N_d is the donor density (cm^{-3}), E_{FB} is the flat band potential, K_b is the Boltzmann constant (1.38 × 10^{-23} J/K) and *T* is the absolute temperature [3, 4]. From Equation N_d can be determined from the slope of the experimental $1/C^2$ versus *E* plots, and E_{fb} from the extrapolation of the linear portion to $1/C^2 = 0$.

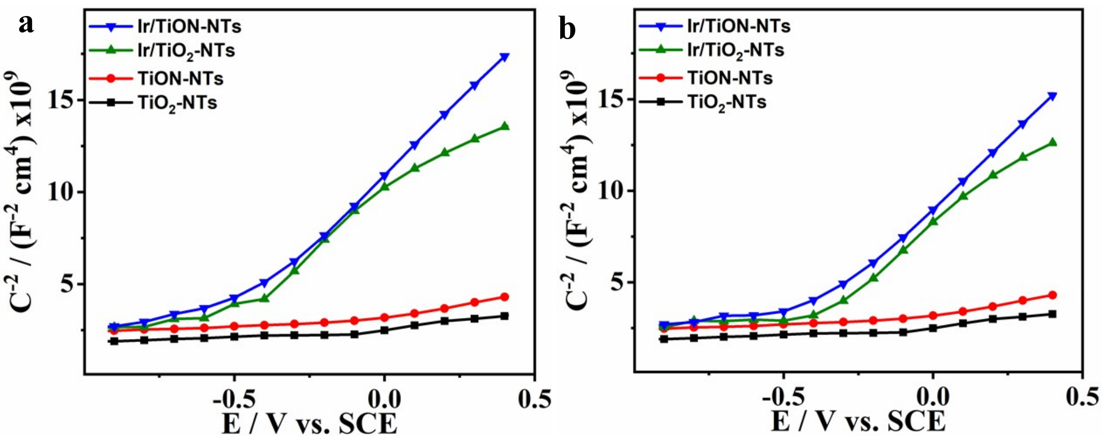

Figure S6. Mott-Schottky plot of the typically prepared materials benchmarked in an aqueous solution of 0.1 M KOH in a potential range from -1 to 0.5 V vs SCE at 100 Hz frequency a) dark and b) light.