Supplementary Materials

Preparation of C_3N_4 thin films for photo-/electrocatalytic CO_2 reduction to produce liquid hydrocarbons

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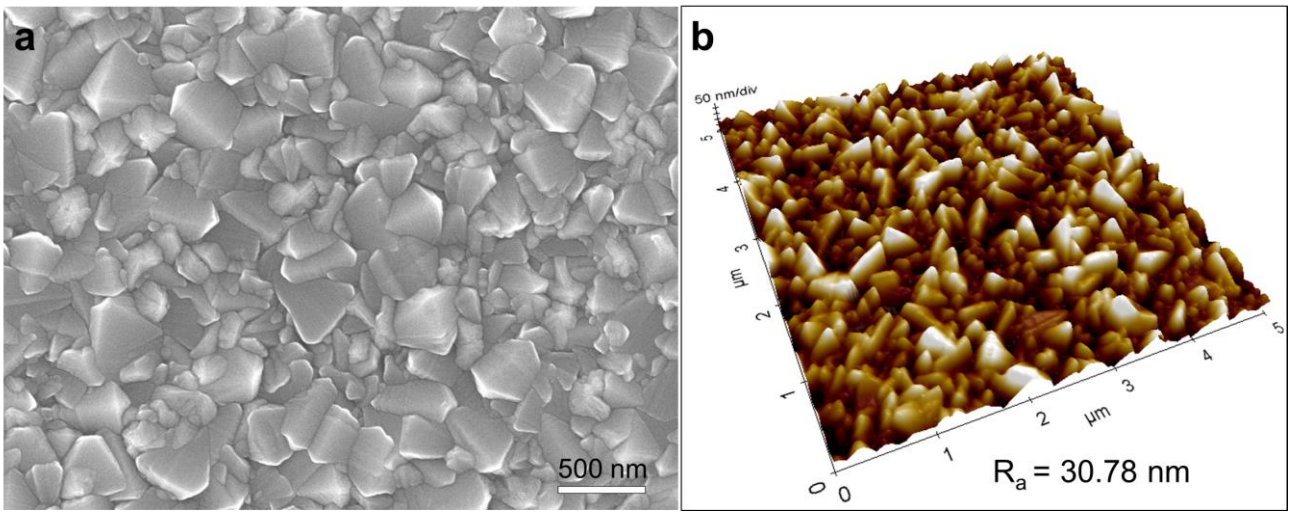

Figure S1. (a) SEM and (b) AFM images of the bare FTO glass substrate.

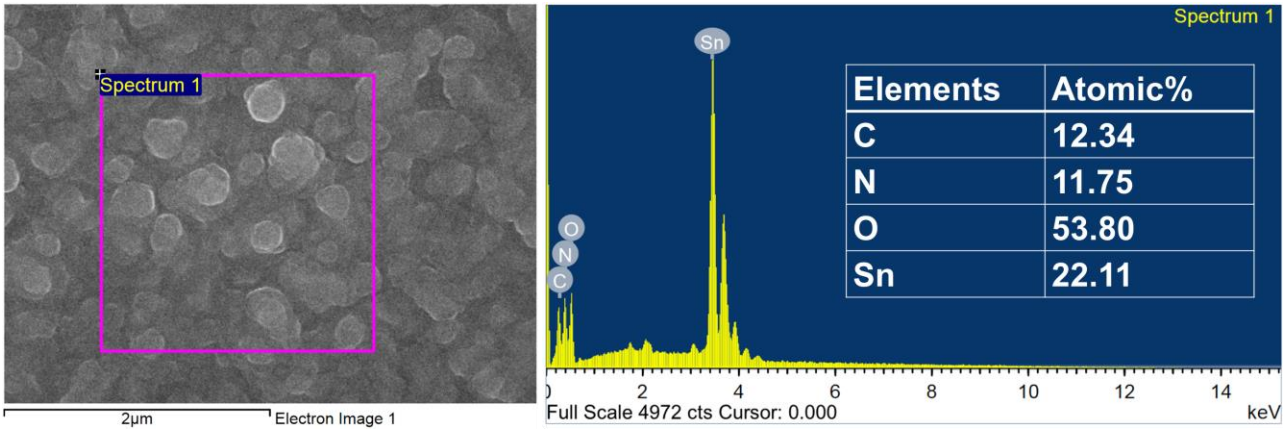

Figure S2. SEM-EDS of the CN/FTO-520 film.

Lifetime subcomponents and average lifetime

Fitting results of PL lifetime decay curves of CN/FTO films derived from $I(t) = A_1\exp(-t/\tau_1) + A_2\exp(-t/\tau_2) + A_3\exp(-t/\tau_3) + \ldots + \sum_i A_i/(A_1 + A_2 + A_3 + \cdots)=1$. The average lifetime can be defined in two ways.

(1) Intensity-weighted average lifetime:

$$\tau_{\text{av-int}} = \sum_{i=1}^{3} A_i\tau_i^2 \,/\, \sum_{i=1}^{3} A_i\tau_i$$

(2) Amplitude-weighted average lifetime:

$$\tau_{\text{av-amp}} = \sum_{i=1}^{3} A_i\tau_i \,/\, \sum_{i=1}^{3} A_i$$

where $\tau_{\text{av-int}}$ equals the average amount of time for which the emitter (e.g. fluorophores) remain in their excited state after the onset of excitation. $\tau_{\text{av-amp}}$ is proportional to the steady state intensity.

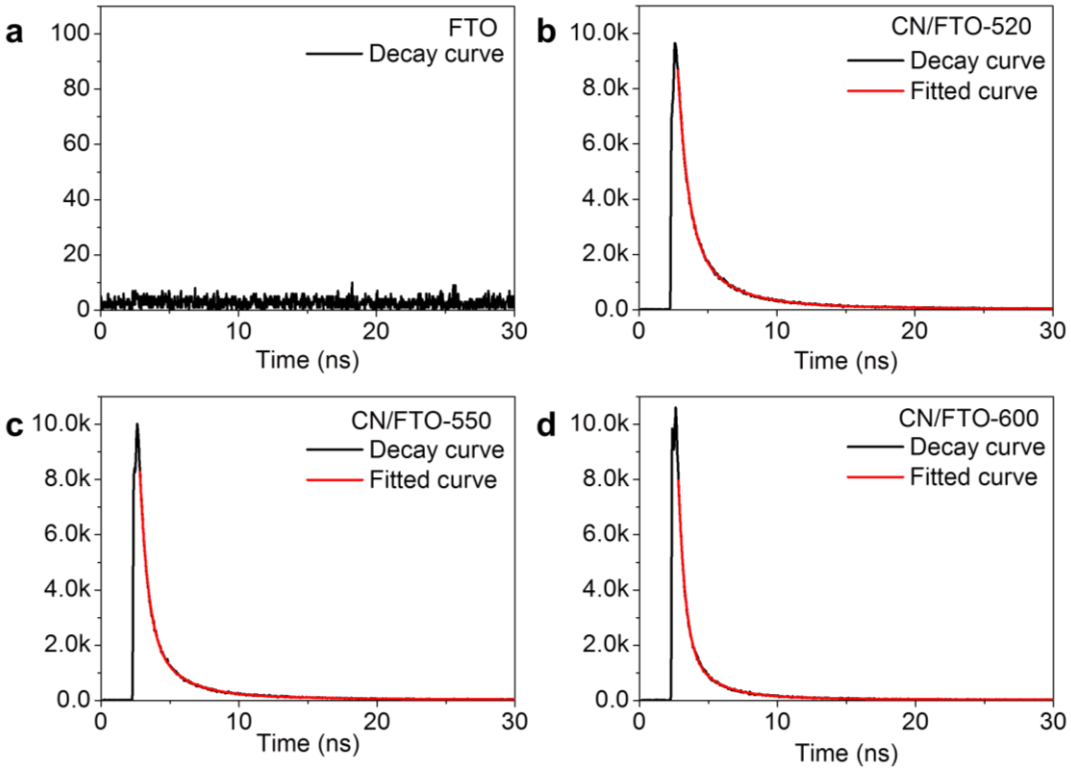

Figure S3. PL lifetime decay curves and their fitted curves of different films. (a) FTO, (b) CN/FTO-520, (c) CN/FTO-550, and (d) CN/FTO-600.

Table S1. Fitting results of PL lifetime decay curves and their corresponding average lifetime.

Samples	A_1	τ_1 (ns)	A_2	τ_2 (ns)	A_3	τ_3 (ns)	$\tau_{av\text{-}int}$ (ns)	$\tau_{av\text{-}amp}$ (ns)
CN/FTO-520	2.6	2.77	0.223	12	5.96	0.748	3.9	1.639
CN/FTO-550	2.24	2.39	0.2007	12	5.98	0.601	3.82	1.346
CN/FTO-600	6.08	0.4991	0.1463	11	1.93	2.08	3.12	1.059

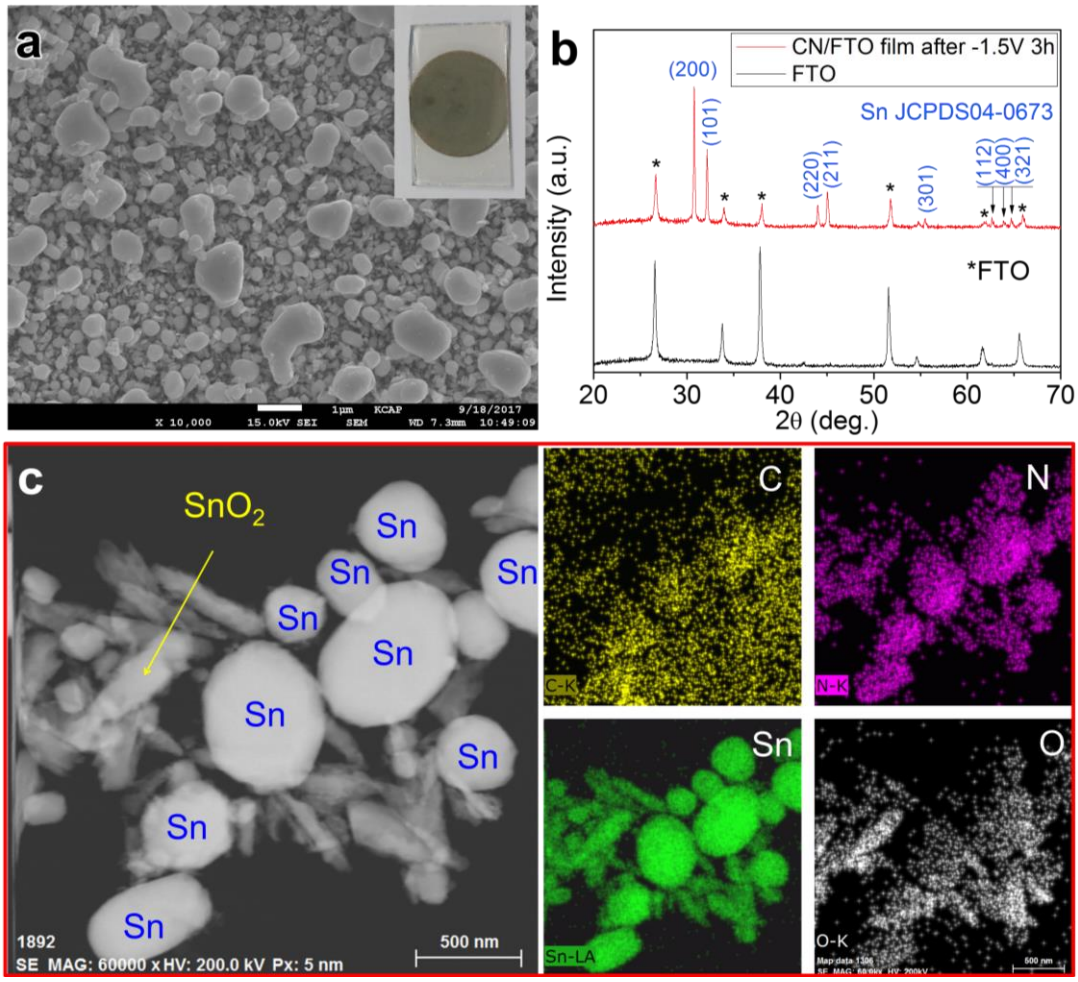

Figure S4. (a) SEM images and (b) XRD, (c) STEM-EDS of CN/FTO-520 film after electrochemical CO_2 reduction at -1.5 V *vs* Ag/AgCl (-0.842 V_{RHE}) for 3 h in CO_2-saturated 0.5 M $KHCO_3$ aqueous solution. The inset in (a) is the photograph of the film after reduction at -0.842 V_{RHE} for 3 h.