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Supporting Information

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Calculation method and equations

The Cl^--removal capacity (Cl^--RC), Cl^--removal rate (Cl^--RR) and energy consumption (EC) are calculated using following equations, respectively.

$$Cl^- \text{-RC (mg-}Cl^- \text{/g-electrode)} = \frac{(C_0 - C_e) \times V \times 35.5 \times 1000}{m} \quad (1)$$

$$Cl^- \text{-RR (mg-}Cl^- \text{/g-electrode/min)} = \frac{Cl^- \text{-RC}}{t} \times 60 \quad (2)$$

$$\text{EC (kWh/kg-}Cl^-\text{)} = \frac{i \times \int v dt}{3600 \times (C_0 - C_e) \times V \times 35.5} \quad (3)$$

Where the C_0 means the initial concentration of NaCl, mol/L; C_e represents the concentration of NaCl after charging, mol/L; V shows the volume of NaCl, L; m denotes the mass of Cl^- storage electrode, g; t signifies the desalination time, s; i and v expresses the current (A) and potential (V) during desalination process, respectively.

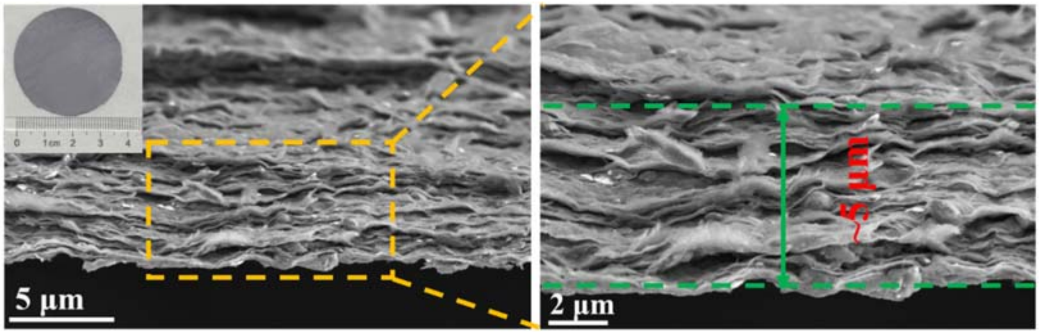

Figure S1. SEM images of $Ti_3C_2T_x$/Ag-3 hybrid (The inset: Digital photograph).

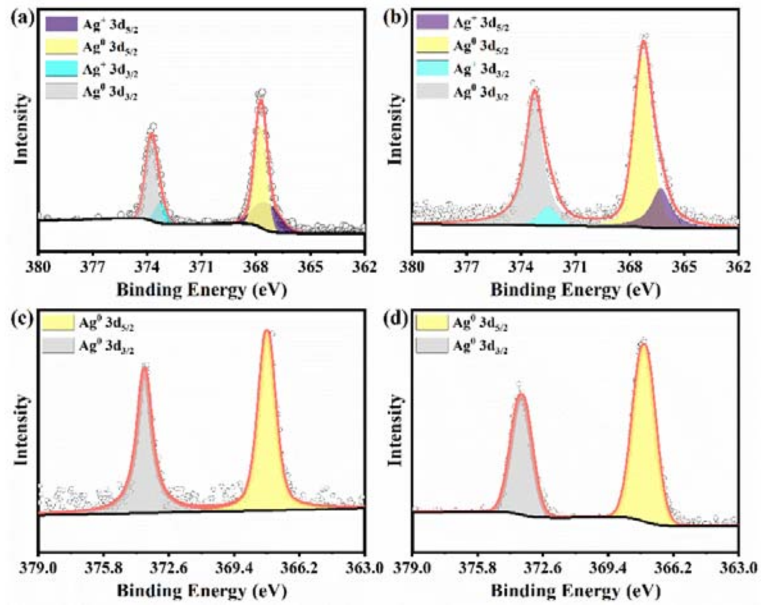

Figure S2. High-resolution Ag 3d XPS spectra of $Ti_3C_2T_x$/Ag hybrid: a) $Ti_3C_2T_x$/Ag-3, b) $Ti_3C_2T_x$/Ag-6, c) $Ti_3C_2T_x$/Ag-9 and d) $Ti_3C_2T_x$/Ag-12.

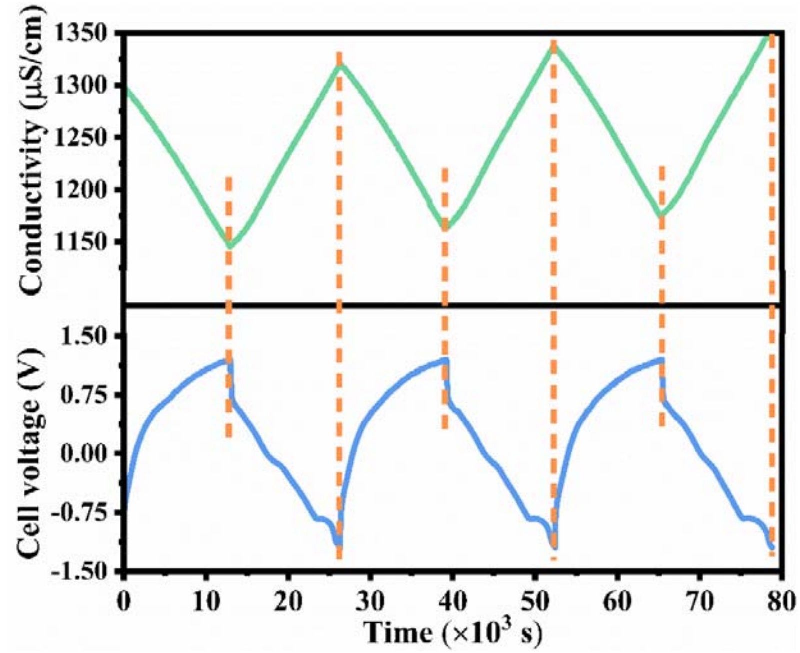

Figure S3. The conductivity (upper) and cell voltage change (lower) during the desalination process of $Ti_3C_2T_x$/Ag-3 at 20 mA/g.

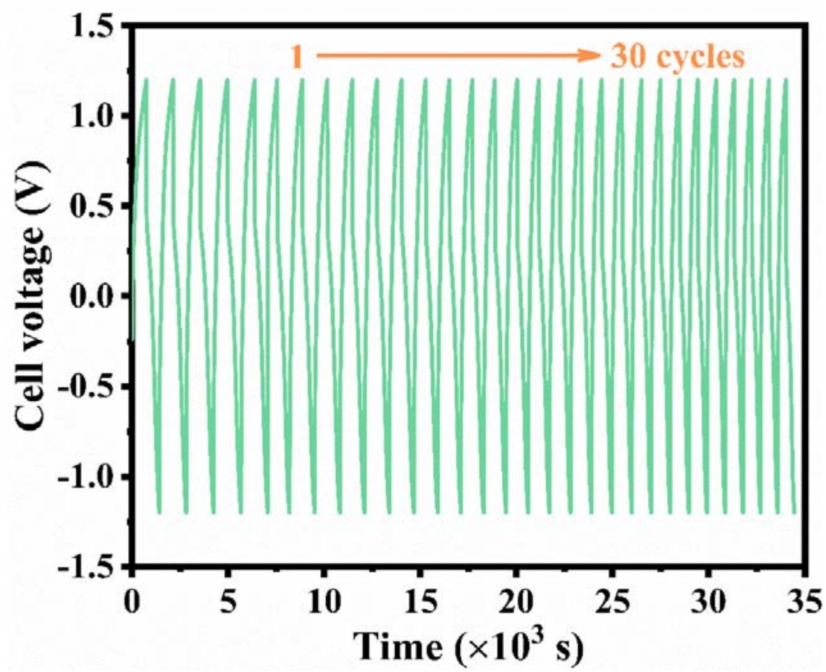

Figure S4. Potential curves of $Ti_3C_2T_x$/Ag-3 electrode at 100 mA/g during 30 desalination cycles.

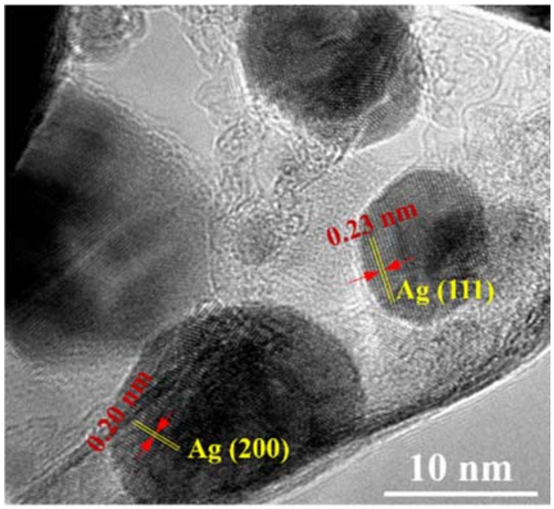

Figure S5. High-resolution TEM image of $Ti_3C_2T_x$/Ag-3 electrode after a long-term cycling.

Table S1. The content of Ag and AgCl species in $Ti_3C_2T_x$/Ag hybrid (EDX measurement).

Electrode materials	Weight percent of Ag^0 (wt%)	Weight percent of AgCl (wt%)	Weight percent of total Ag (wt%)
$Ti_3C_2T_x$/Ag-3	7.90	17.68	21.22
$Ti_3C_2T_x$/Ag-6	12.52	8.64	19.03
$Ti_3C_2T_x$/Ag-9	19.79	-	19.79
$Ti_3C_2T_x$/Ag-12	21.01	-	21.01

Table S2. The content of Ag and AgCl species in $Ti_3C_2T_x$/Ag-3 hybrid after different operation (EDX measurement).

Operation	Weight percent of Ag^0 (wt%)	Weight percent of AgCl (wt%)	Weight percent of total Ag (wt%)
Before inverse-voltage washing	7.90	17.68	21.22
After inverse-voltage washing	17.21	6.18	21.86
After long-term cycling	19.63	1.90	21.06