Supporting Information

Design of High-Performance Antimony / MXene Hybrid Electrodes for Sodium-Ion Batteries

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**Figure S1:** X-ray diffraction patterns of different Sb@Ti$_3$C$_2$T$_z$ hybrid materials (+pure Ti$_3$C$_2$T$_z$ and expanded Ti$_3$C$_2$T$_z$) by using the MXene etched with 5 mass% HF (A) and 30 mass% HF (B).

**Figure S2:** Particle size distribution derived from image analysis of scanning electron micrographs of 150 antimony particles synthesized via synthesis Route A (A) and via synthesis Route B (B).
Figure S3: Scanning electron micrographs of (A) antimony Ti$_3$C$_2$T$_2$ (5 mass% HF) hybrid with a composition of 7:3 (B) antimony expanded Ti$_3$C$_2$T$_2$ (5 mass% HF) hybrid with a composition of 7:3 (C) antimony Ti$_3$C$_2$T$_2$ (30 mass% HF) hybrid with a composition of 7:3 (D) antimony expanded Ti$_3$C$_2$T$_2$ (30 mass% HF) hybrid with a composition of 7:3.
Figure S4: Material characterization of the different MXenes. Scanning electron micrographs of (A-B) Ti$_3$C$_2$T$_2$ (5 mass% HF), (C-D) with TMAOH expanded Ti$_3$C$_2$T$_2$ (5 mass% HF), (E-F) Ti$_3$C$_2$T$_2$ (30 mass% HF), (G-H) with TMAOH expanded Ti$_3$C$_2$T$_2$ (30 mass% HF).
Figure S5: Material characterization of the different with TMAOH expanded MXene antimony hybrids. Scanning electron micrographs of (A-B) antimony expanded Ti$_3$C$_2$T$_x$ (5 mass% HF) hybrid with a composition of 6:4, (C-D) antimony expanded Ti$_3$C$_2$T$_x$ (5 mass% HF) hybrid with a composition of 7:3, (E-F) antimony expanded Ti$_3$C$_2$T$_x$ (30 mass% HF) hybrid with a composition of 6:4, (G-H) antimony expanded Ti$_3$C$_2$T$_x$ (30 mass% HF) hybrid with a composition of 7:3.
Figure S6: Material characterization of the different MXenes hybrids. Scanning electron micrographs of (A-B) antimony Ti$_3$C$_2$T$_x$ (5% mass% HF) hybrid with a composition of 6:4, (C-D) antimony Ti$_3$C$_2$T$_x$ (5% mass% HF) hybrid with a composition of 7:3, (E-F) antimony Ti$_3$C$_2$T$_x$ (30% mass% HF) hybrid with a composition of 6:4, (G-H) antimony Ti$_3$C$_2$T$_x$ (30% mass% HF) hybrid with a composition of 7:3.
Figure S7: Cyclic voltammograms recorded at 0.1 mV s$^{-1}$ in the potential range of 0.1-2.0 V vs. Na$^+$/Na for (A) antimony Ti$_3$C$_2$T$_2$ (5% mass% HF) hybrid with a composition of 6:4, (B) antimony Ti$_3$C$_2$T$_2$ (5% mass% HF) hybrid with a composition of 7:3, (C) antimony expanded Ti$_3$C$_2$T$_2$ (5% HF) hybrid with a composition of 6:4, (D) antimony expanded Ti$_3$C$_2$T$_2$ (5% mass% HF) hybrid with a composition of 7:3, (E) v Ti$_3$C$_2$T$_2$ (5% mass% HF), (F) not expanded Ti$_3$C$_2$T$_2$ (5% mass% HF).
Figure S8: Cyclic voltammograms recorded at 0.1 mV s⁻¹ in the potential range of 0.1-2.0 V vs. Na⁺/Na for (A) antimony Ti₃C₂T₂ (30% mass% HF) hybrid with a composition of 6:4, (B) antimony Ti₃C₂T₂ (30% mass% HF) hybrid with a composition of 7:3, (C) antimony expanded Ti₃C₂T₂ (30% mass% HF) hybrid with a composition of 6:4, (D) antimony expanded Ti₃C₂T₂ (30% mass% HF) hybrid with a composition of 7:3, (E) expanded Ti₃C₂T₂ (30% mass% HF), (F) not expanded Ti₃C₂T₂ (30% mass% HF).
Figure S9: Galvanostatic charge and discharge profiles at different applied specific currents of 0.1-8 A g\(^{-1}\) between 1.0 V and 3.0 V vs. Na\(^+\)/Na of (A) Sb@A_MX_HF5(7:3), (B) Sb@B_MX_HF5(7:3), (C) Sb@A_MX_HF30(6:4), (D) Sb@B_MX_HF30(6:4), (E) Sb@A_MX_HF30(7:3), and (F) Sb@B_MX_HF30(7:3).
Figure S10: Electrochemical characterization of the non-expanded and expanded Ti$_3$C$_2$T$_x$, etched with 5 mass% HF. Galvanostatic charge and discharge profiles at rates of 0.1-8 A g$^{-1}$ (1.0-3.0 V vs. Na$^+$/Na) of (A) MX_HF5, (B) MX_HF30, (C) A_MX_HF5, and (D) A_MX_HF30. Rate performance using galvanostatic charge/discharge cycling and Coulombic efficiency values at different rates for (E) MX_HF5 and A_MX_HF5, (F) MX_HF30 and A_MX_HF30. Galvanostatic charge/discharge cycling stability and Coulombic efficiency values at a specific current of 0.1 A g$^{-1}$ for (G) MX_HF5 and A_MX_HF5, (H) MX_HF30 and A_MX_HF30.
Figure S11: Galvanostatic charge/discharge cycling performance electrochemical stability with corresponding Coulombic efficiency values at a specific current of 0.1 A g\(^{-1}\) for (A) Sb+MX_HF5(6:4)_MM, and (B) Sb+MX_HF5(7:3)_MM. Cyclic voltammograms recorded at a rate of 0.1 mV s\(^{-1}\) in the potential range of 0.1-2.0 V vs. Na\(^+\)/Na for (C) Sb+MX_HF5(6:4)_MM, and (D) Sb+MX_HF5(7:3)_MM.
Figure S12: X-ray diffraction pattern of (A) pristine and post mortem Sb@B_MX_HF5(6:4) electrode (B) pristine and cycled Sb@A_MX_HF5(6:4) electrode. The diffraction patterns were recorded with the setup XRD-2 (see Experimental).

Figure S13: Graphical illustration and overview of initial specific capacities as well as values after 50 cycles of cycling at a specific current of 0.1 A g⁻¹ of all hybrid antimony MXene hybrid materials produced in this work.