

Supporting Information

In-situ Generated 3D Hierarchical $\text{Co}_3\text{O}_4@\text{MnO}_2$ Core-Shell Hybrid Materials: Self-assembled Fabrication, Morphological Control and Energy Applications

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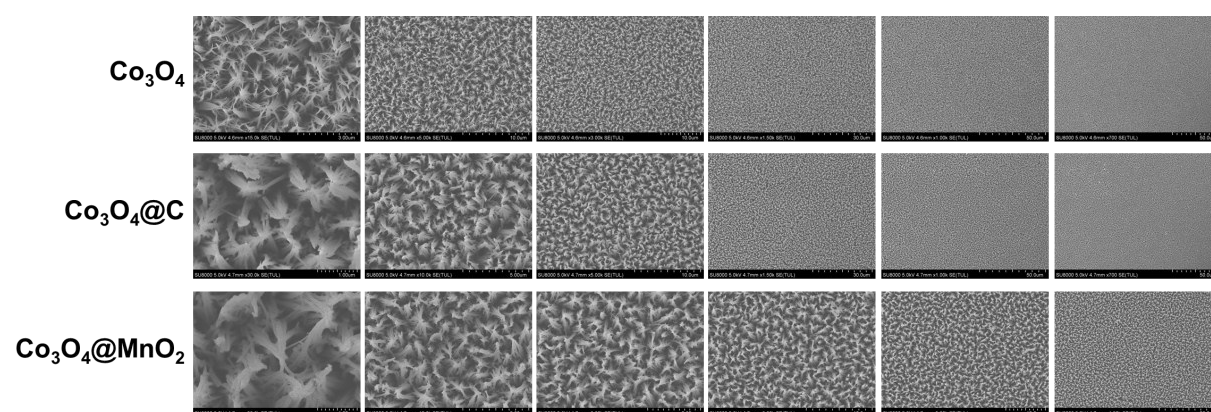


Figure S1. SEM images of the large-scale in-situ 3D hierarchical Co_3O_4 , $\text{Co}_3\text{O}_4@\text{C}$ and $\text{Co}_3\text{O}_4@\text{MnO}_2$ nanoarrays grown on the oblique downward FTO glasses at different magnifications.

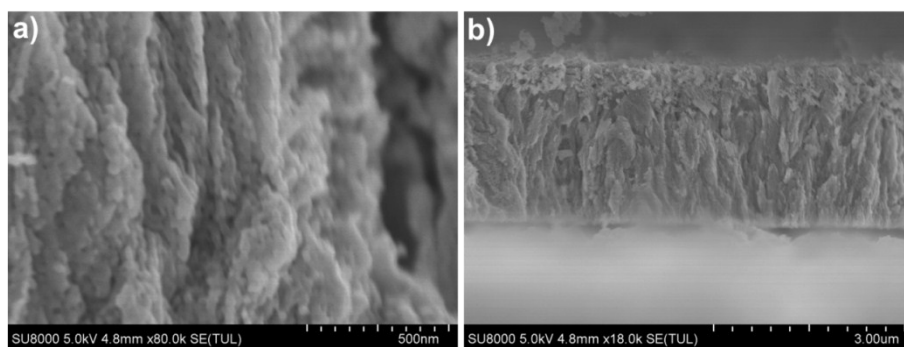


Figure S2. Cross section SEM images of the in-situ 3D hierarchical Co_3O_4 materials grown on the oblique downward FTO glasses at different magnifications.

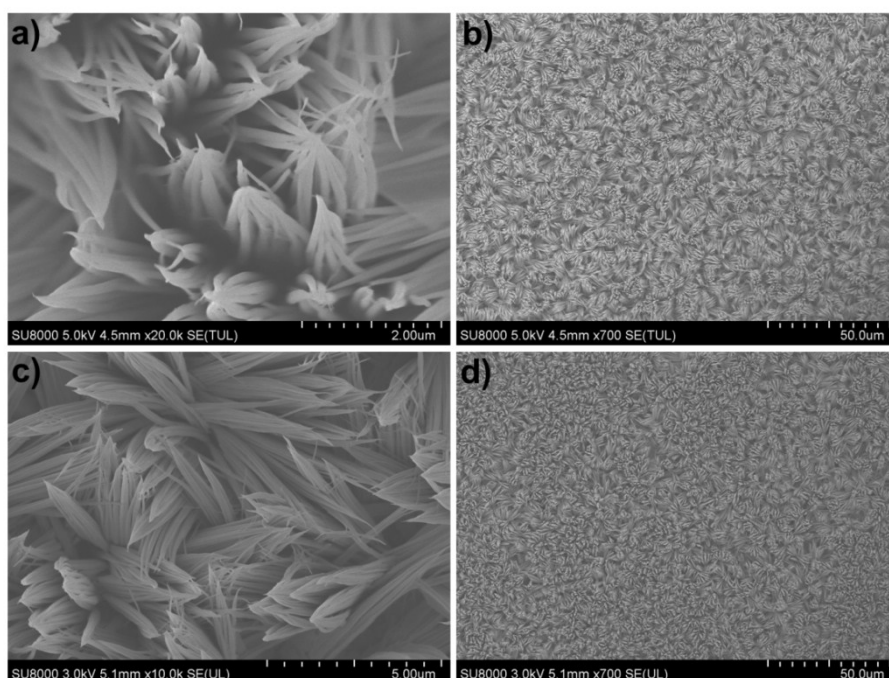


Figure S3. SEM images at different magnifications of the in-situ 3D hierarchical Co_3O_4 nanoarrays on FTO glasses with different orientations. a-b) grown on the oblique upward FTO glass; c-d) grown on the horizontal downward FTO glass.

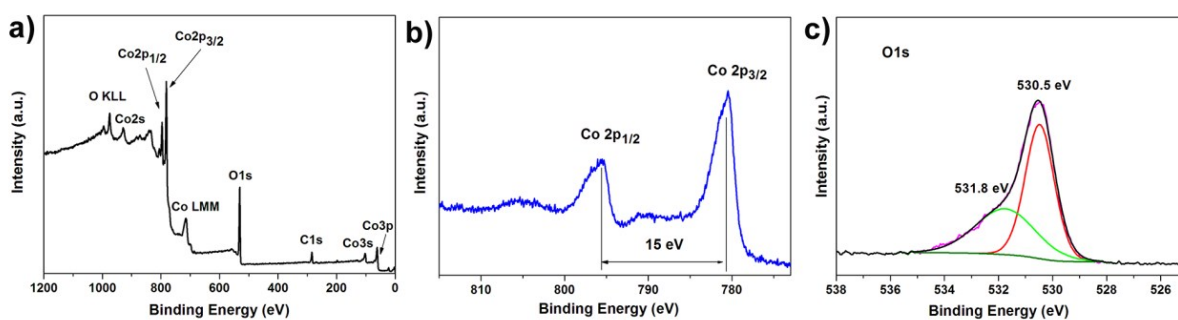


Figure S4. a) XPS spectra of the as-synthesized Co_3O_4 nanoarrays. b-c) XPS survey scan of Co 2p and O 1s, respectively.

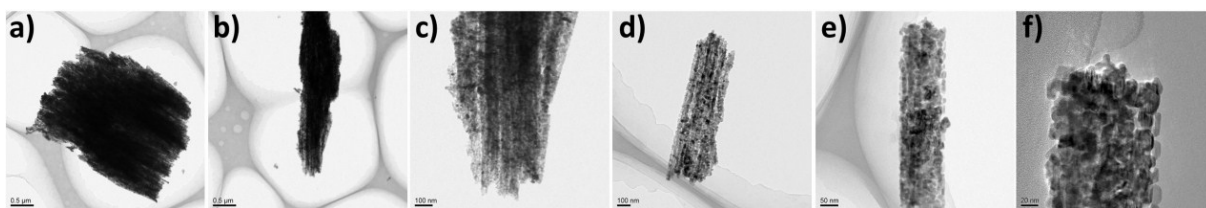


Figure S5. TEM images of the in-situ 3D hierarchical Co_3O_4 nanoarrays at different magnifications.

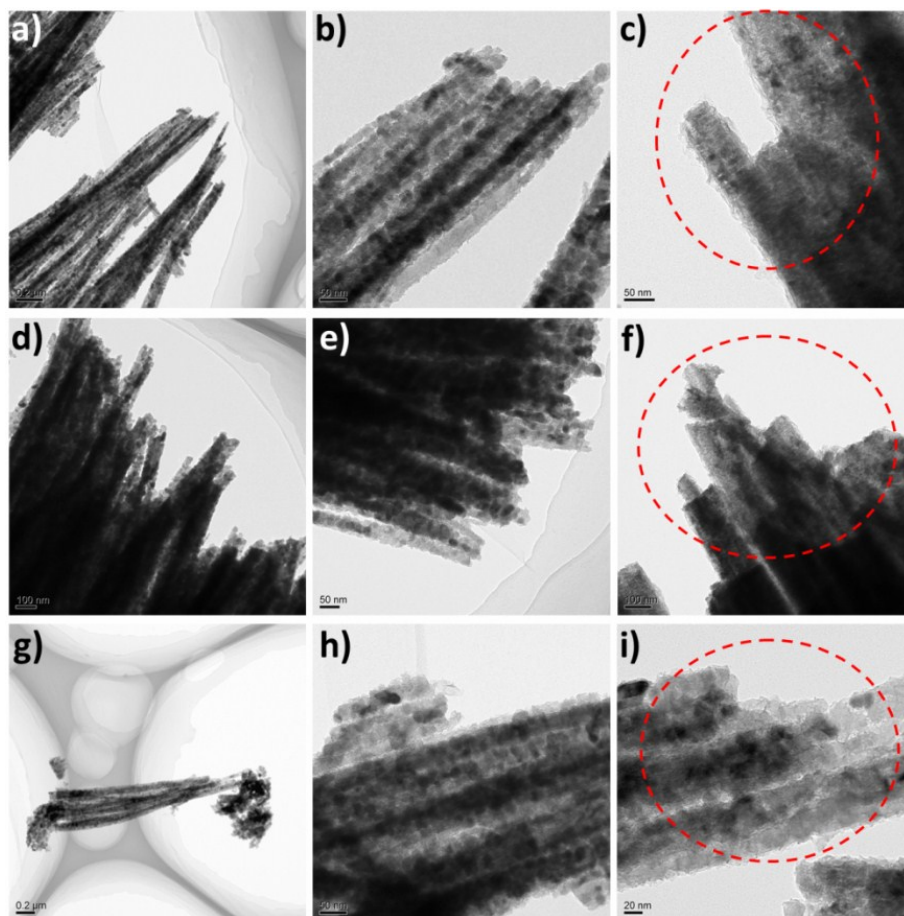


Figure S6. TEM images of the in-situ 3D hierarchical $\text{Co}_3\text{O}_4@\text{MnO}_2$ core-shell hybrid nanoarrays at different magnifications.

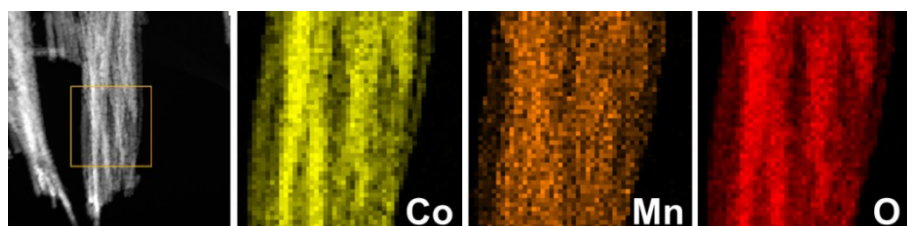


Figure S7. EDS mapping of the in-situ 3D hierarchical $\text{Co}_3\text{O}_4@\text{MnO}_2$ core-shell hybrid nanoarrays.

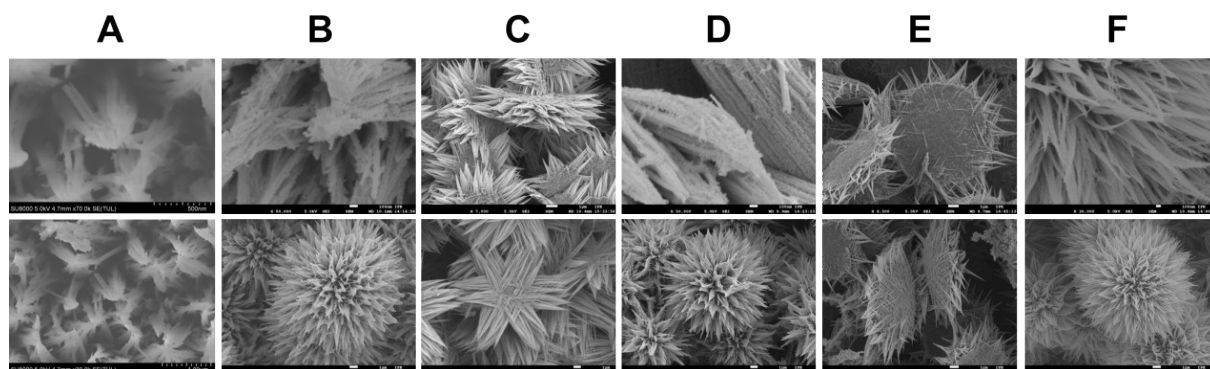


Figure S8. SEM images of the in-situ 3D hierarchical $\text{Co}_3\text{O}_4@\text{C}$ A-F materials with different morphologies.

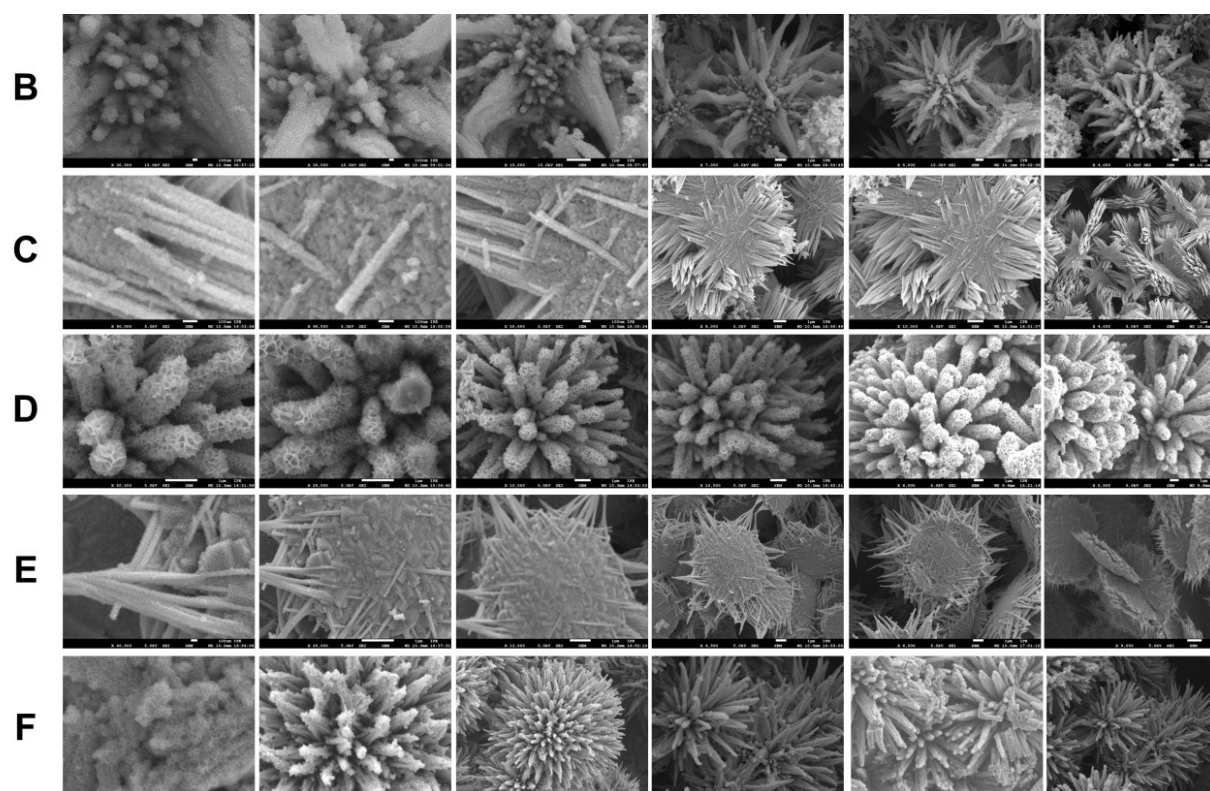


Figure S9. SEM images of the in-situ 3D hierarchical $\text{Co}_3\text{O}_4@\text{MnO}_2$ core-shell hybrid A-F materials with different morphologies.

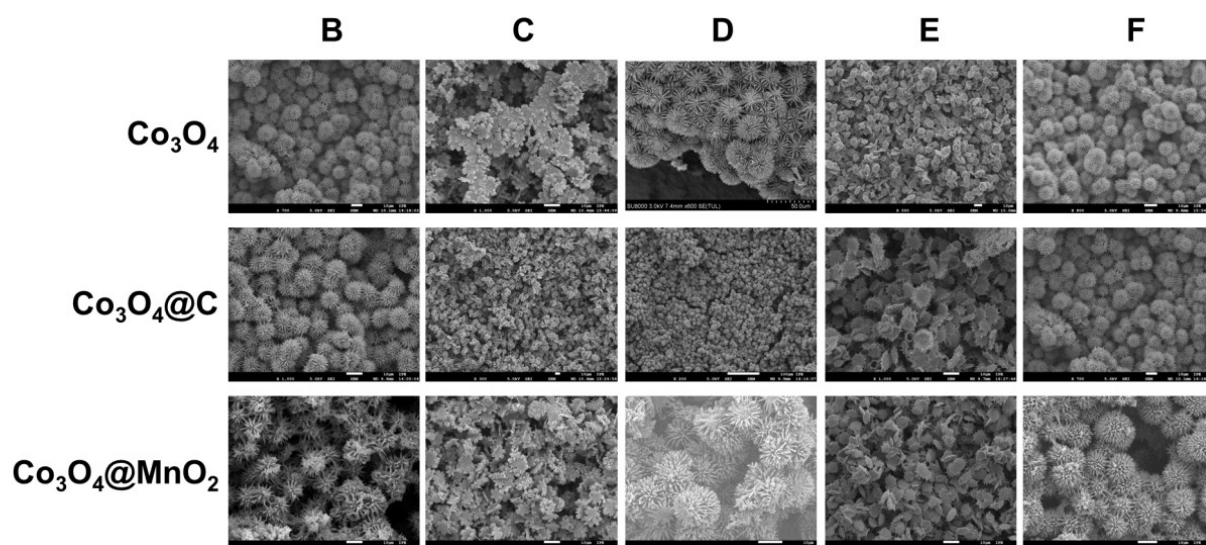


Figure S10. SEM images of the large-scale in-situ 3D hierarchical Co_3O_4 , $\text{Co}_3\text{O}_4@\text{C}$ and $\text{Co}_3\text{O}_4@\text{MnO}_2$ B-F materials.

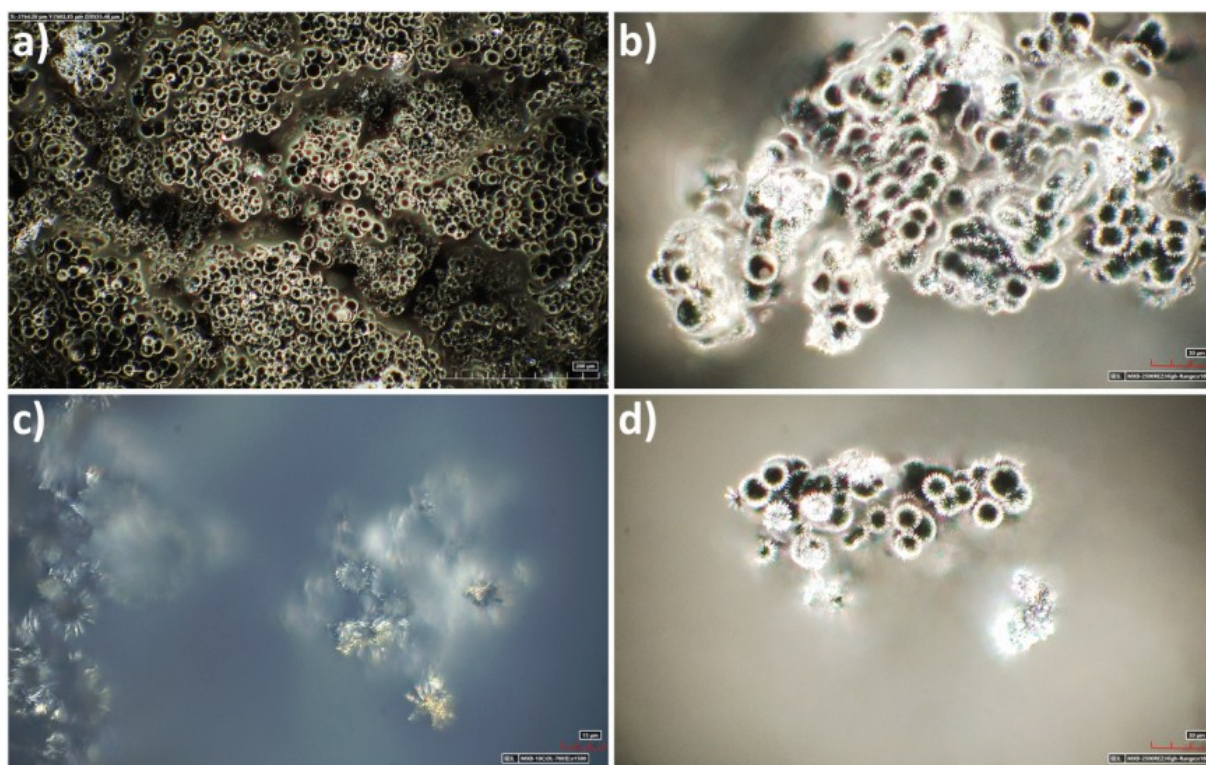


Figure S11. 3D Digital Microscope images of the in-situ synthesized 3D hierarchical a) Co_3O_4 B and b-d) $\text{Co}_3\text{O}_4@\text{MnO}_2$ B.

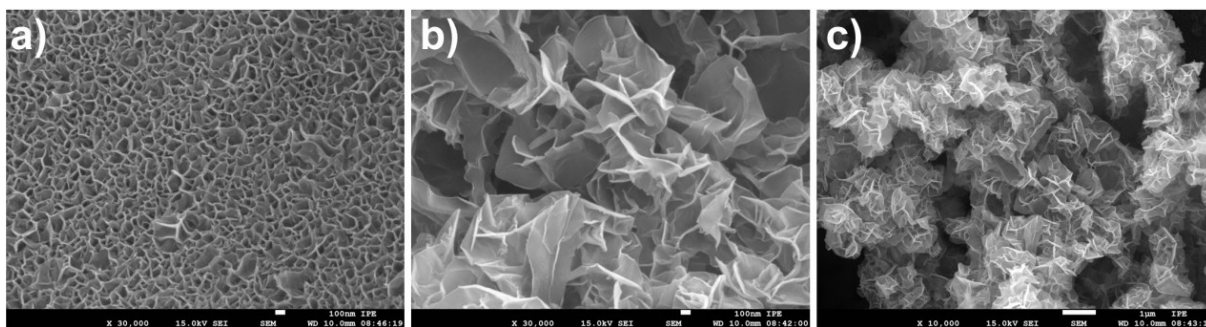


Figure S12. SEM images of the in-situ ultrathin 3D hierarchical a) MnO₂ layer and b-c) the corresponding 3D hierarchical MnO₂ nanoparticles in the in-situ process.

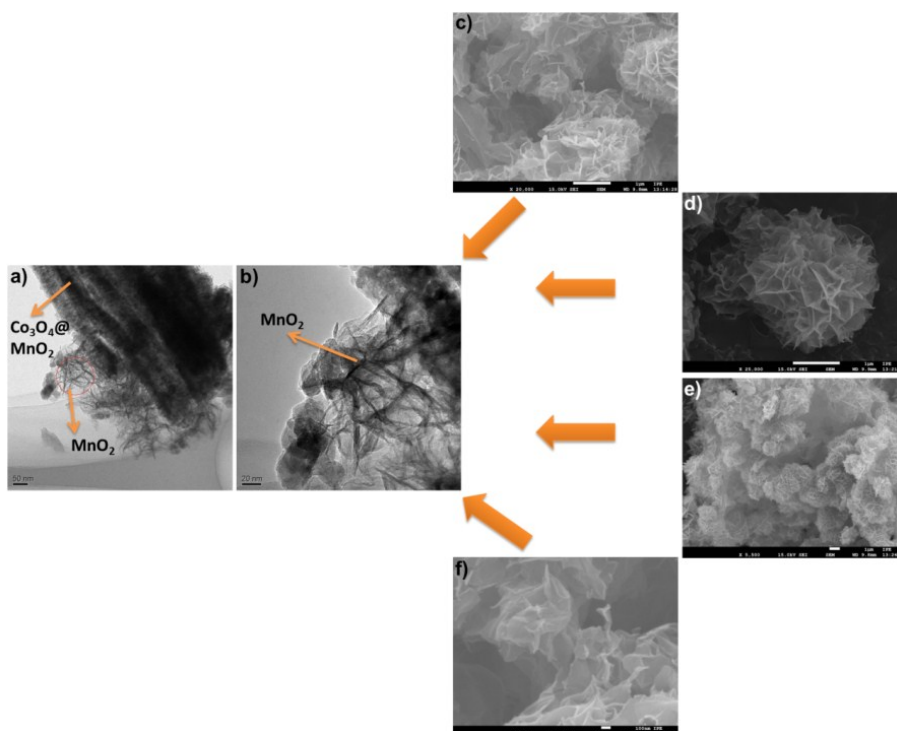


Figure S13. a-b) HRTEM of the MnO₂ layer in the Co₃O₄@MnO₂ hybrid architecture. c-f) HRSEM images of the MnO₂ nanoparticles.

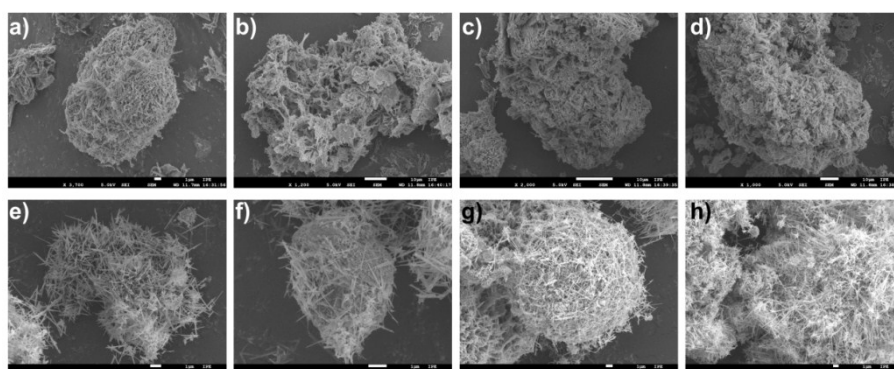


Figure S14. SEM images of a-d) the obtained Co₃O₄ materials and e-f) Co₃O₄@MnO₂ materials synthesized by the traditional method without any substrate.

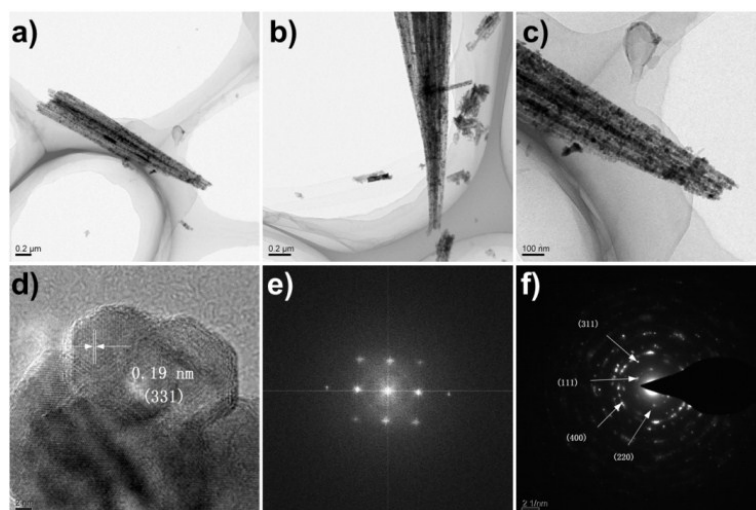


Figure S15. TEM images of the in-situ 3D hierarchical Co_3O_4 material C.

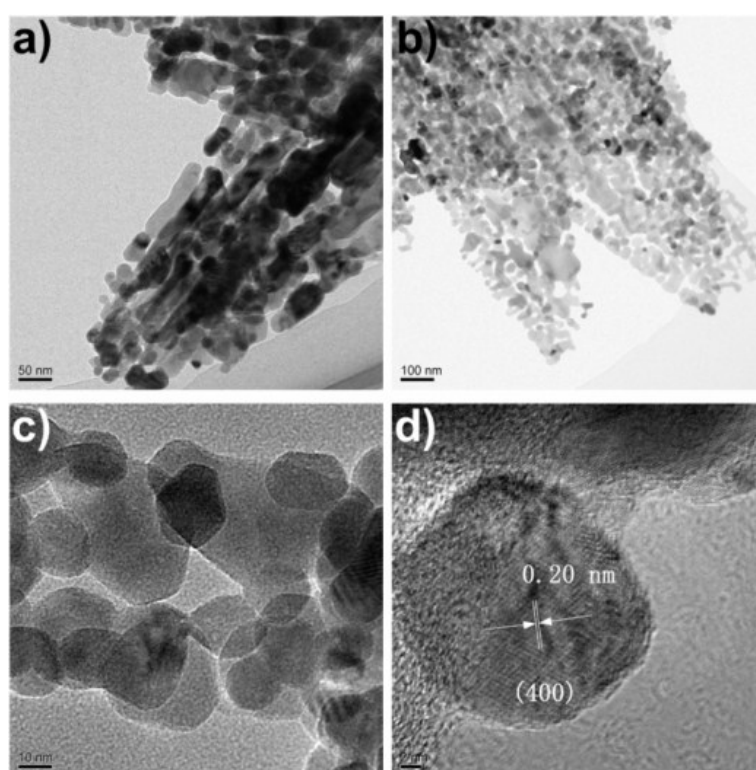


Figure S16. TEM images of the in-situ 3D hierarchical Co_3O_4 material D.

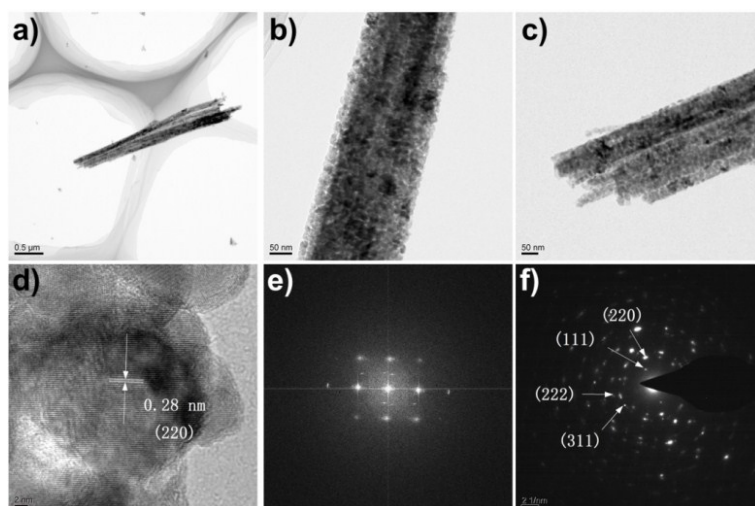


Figure S17. TEM images of the in-situ 3D hierarchical Co_3O_4 material E.

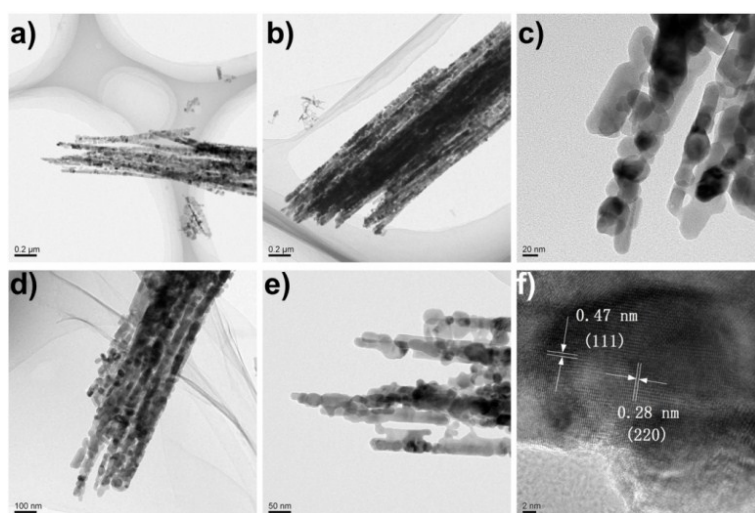


Figure S18. TEM images of the in-situ 3D hierarchical Co_3O_4 material F.

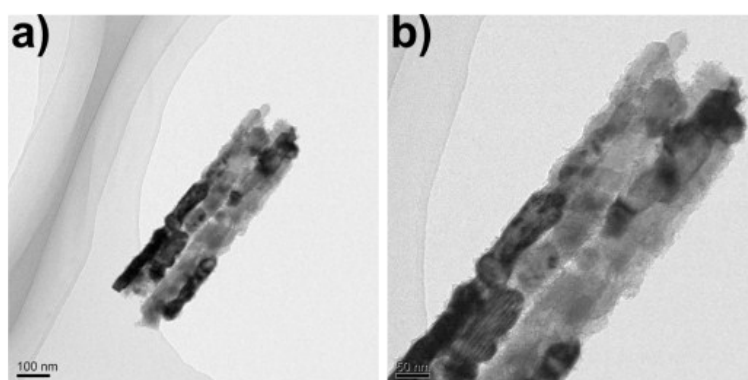


Figure S19. TEM images of the in-situ 3D hierarchical $\text{Co}_3\text{O}_4@\text{MnO}_2$ hybrid material D.

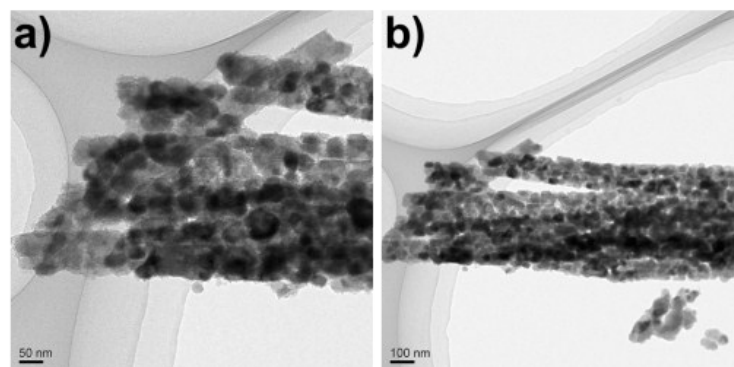


Figure S20. TEM images of the in-situ 3D hierarchical $\text{Co}_3\text{O}_4@\text{MnO}_2$ hybrid material F.

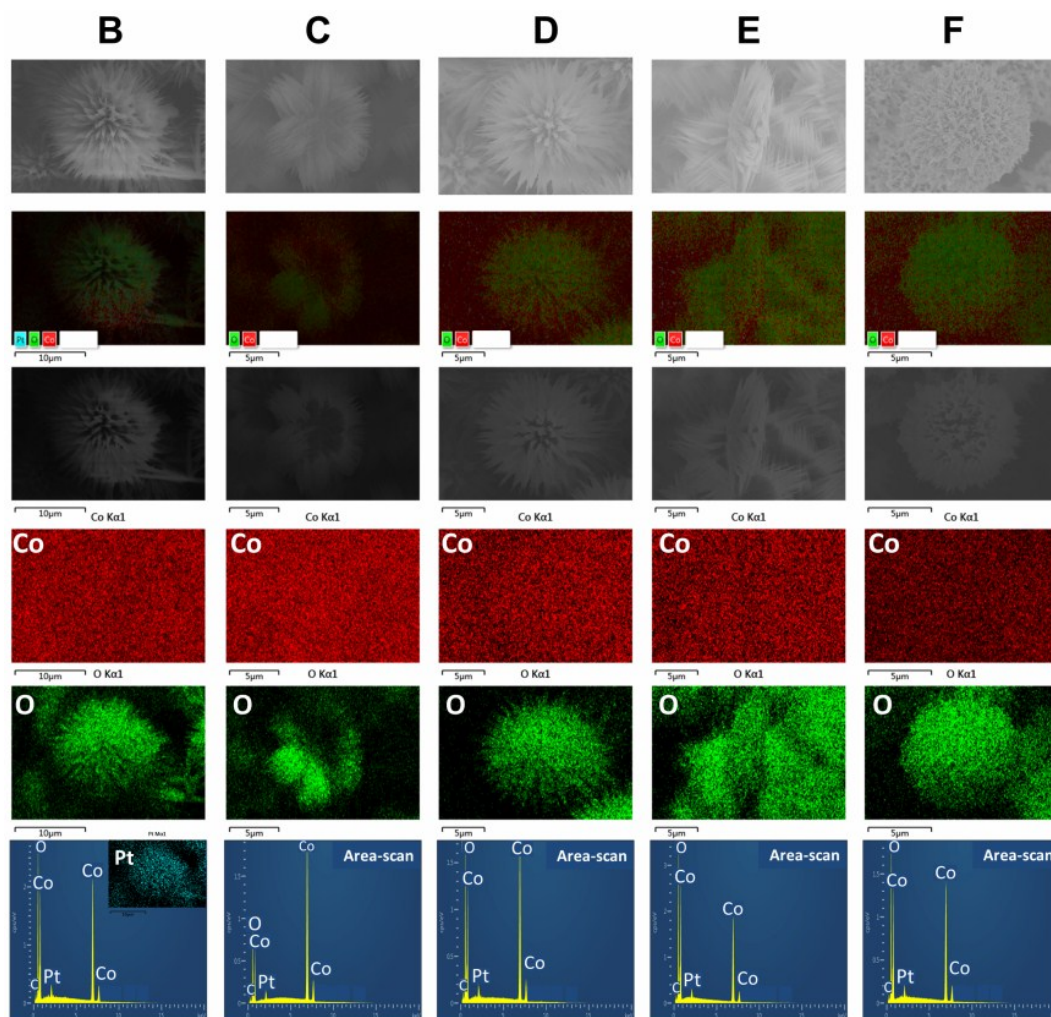


Figure S21. EDS mapping and Area-scan EDS spectra from a whole single $\text{Co}_3\text{O}_4@\text{C}$ 3D hierarchical structure B-F.

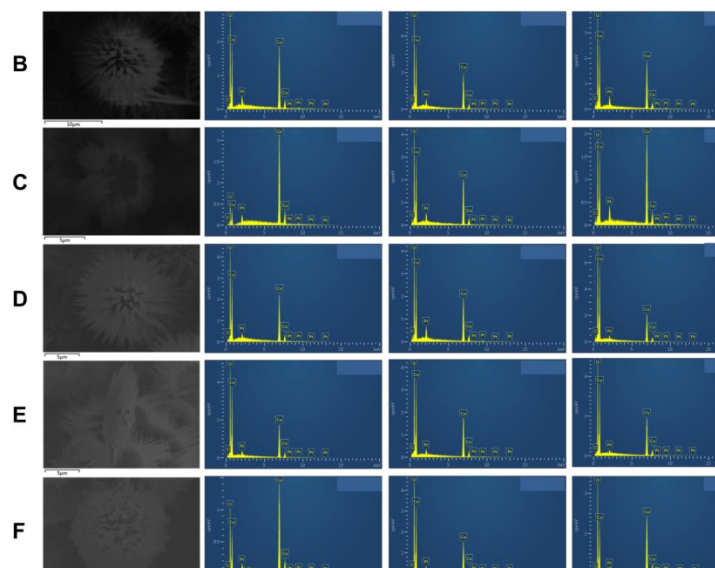


Figure S22. EDS spectra by the spot-scan method from a whole single 3D hierarchical $\text{Co}_3\text{O}_4@\text{C}$ structure (B-F).

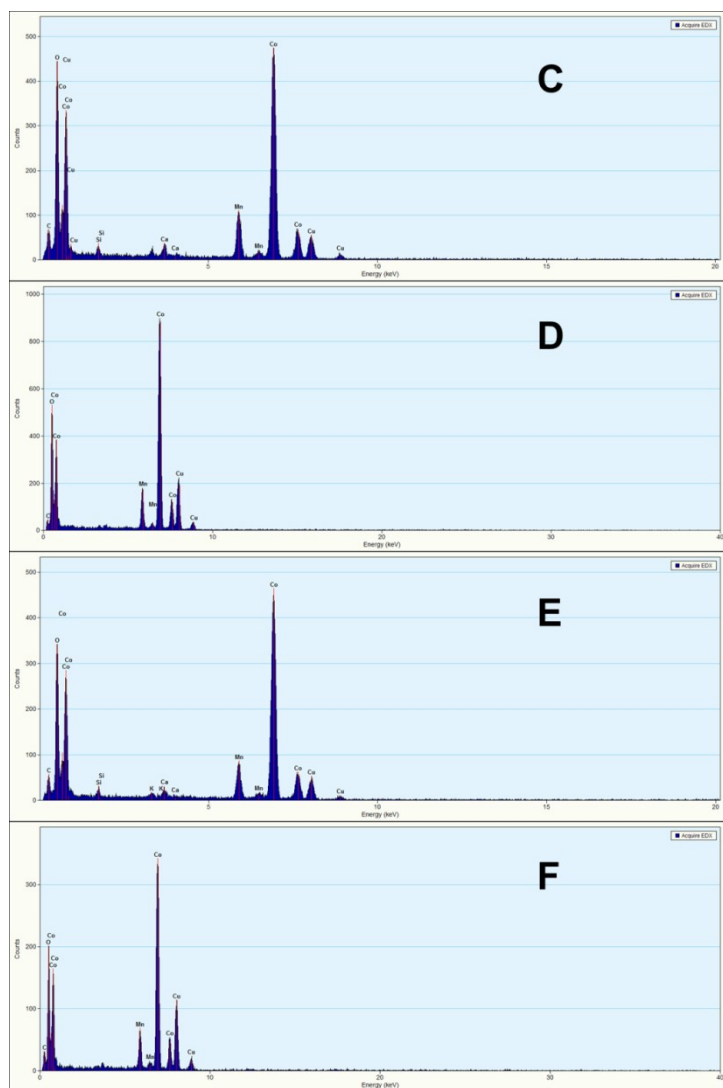


Figure S23. EDS spectra by the spot-scan method from a whole single 3D hierarchical $\text{Co}_3\text{O}_4@\text{MnO}_2$ structure (C-F).

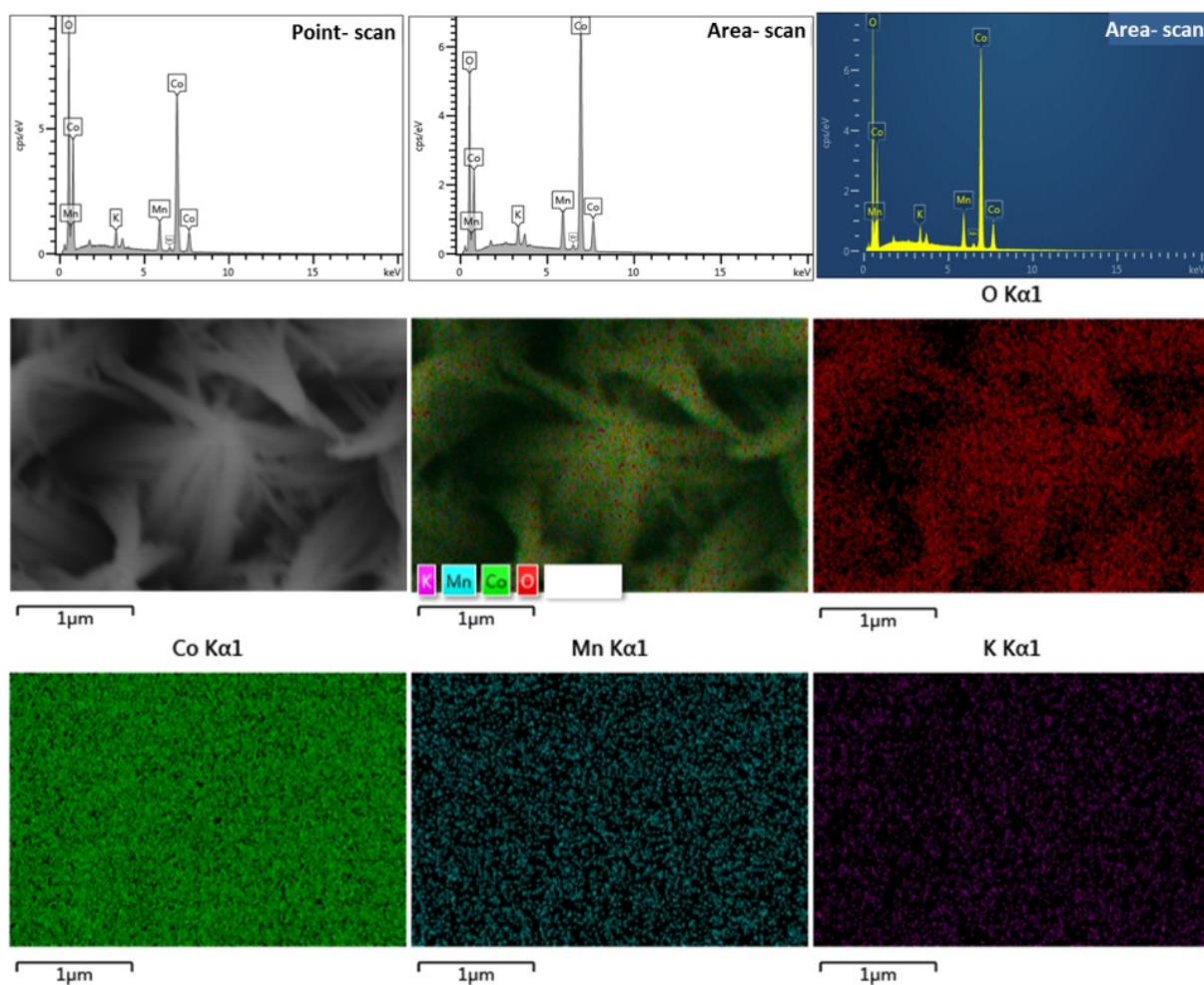


Figure S24. EDS mapping and EDS spectra by both the area-scan and spot-scan methods from a whole single 3D hierarchical $\text{Co}_3\text{O}_4@\text{MnO}_2$ structure (A).

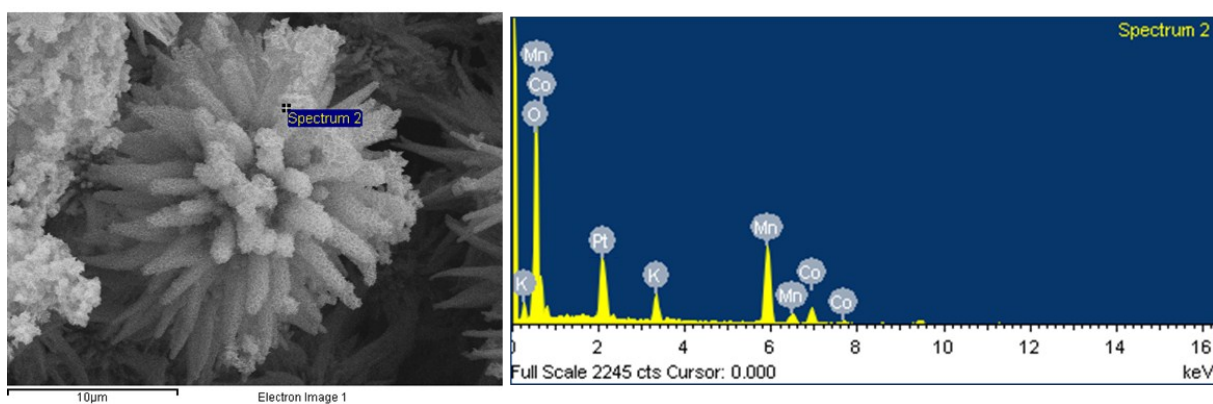


Figure S25. EDS spectra by the spot-scan method from a whole single 3D hierarchical $\text{Co}_3\text{O}_4@\text{MnO}_2$ structure (B).

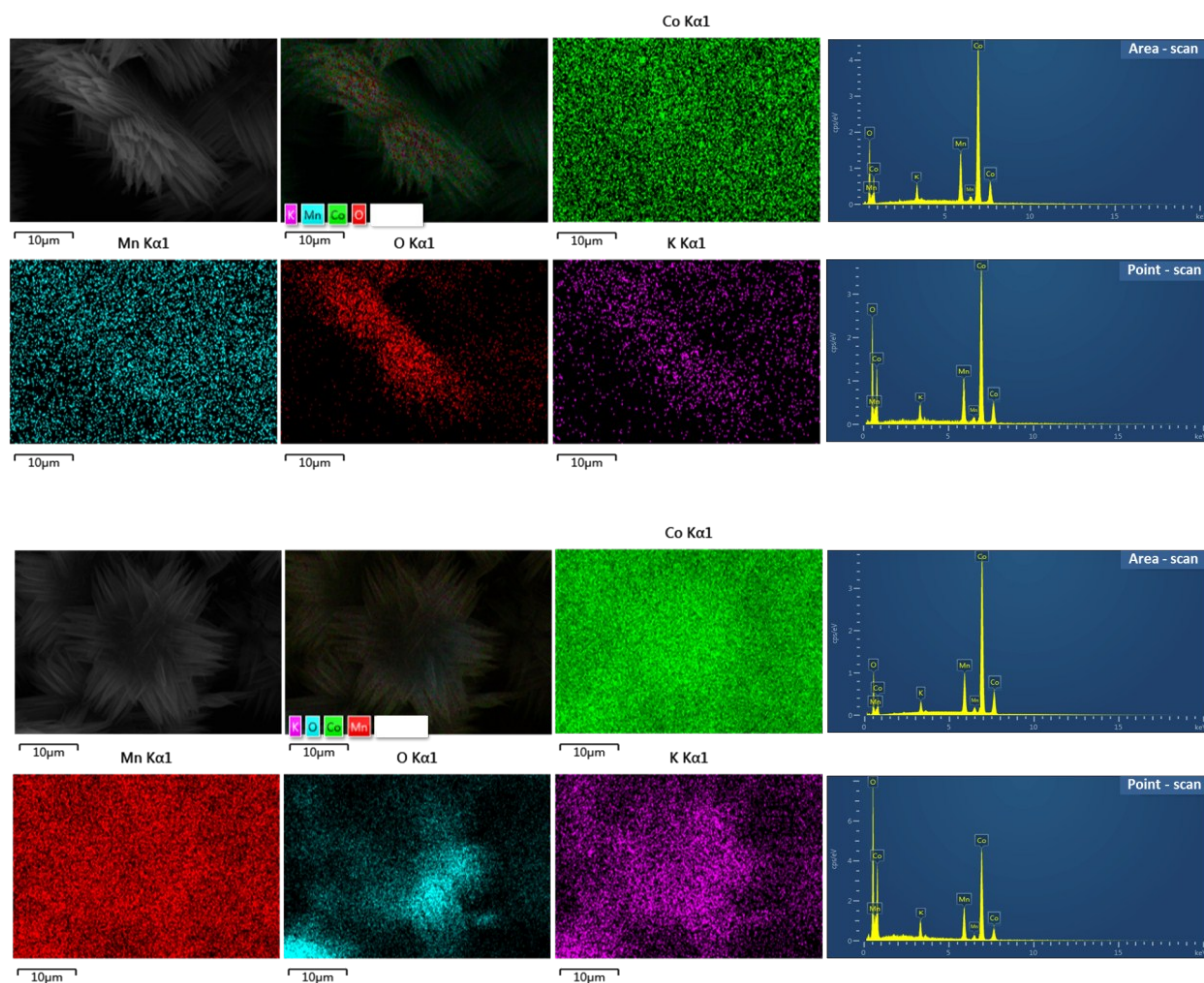


Figure S26. EDS mapping and EDS spectra by both the area-scan and spot-scan methods from a whole single 3D hierarchical $\text{Co}_3\text{O}_4@\text{MnO}_2$ structure (C).

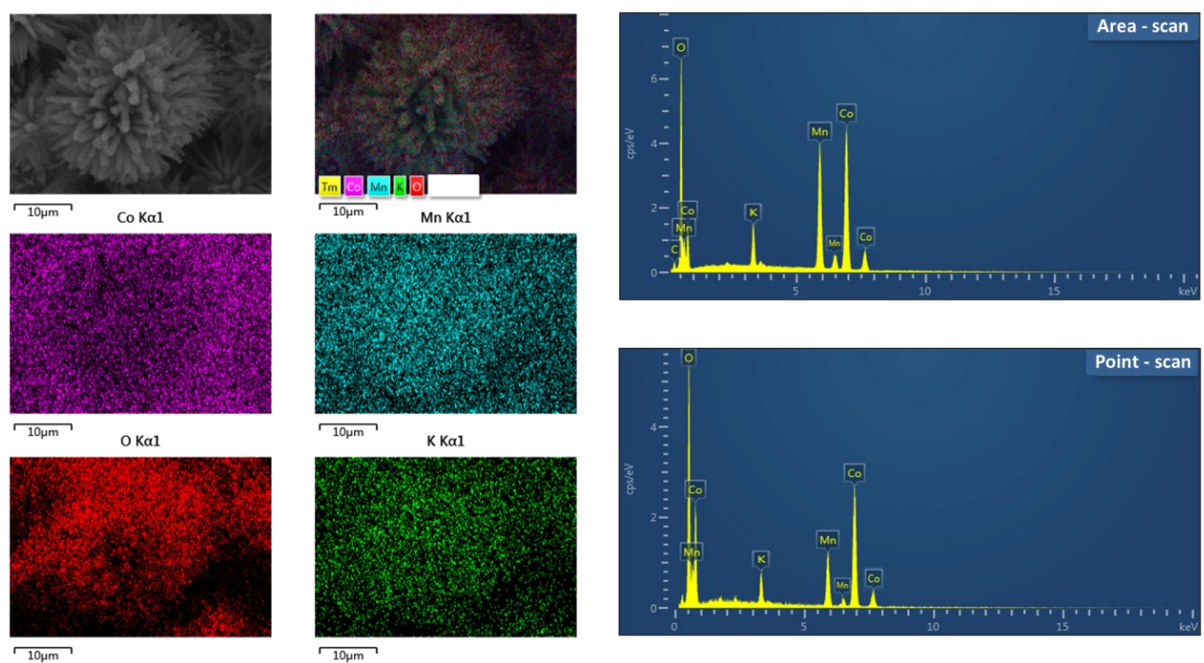


Figure S27. EDS mapping and EDS spectra by both the area-scan and spot-scan methods from a whole single 3D hierarchical $\text{Co}_3\text{O}_4@\text{MnO}_2$ structure (D).

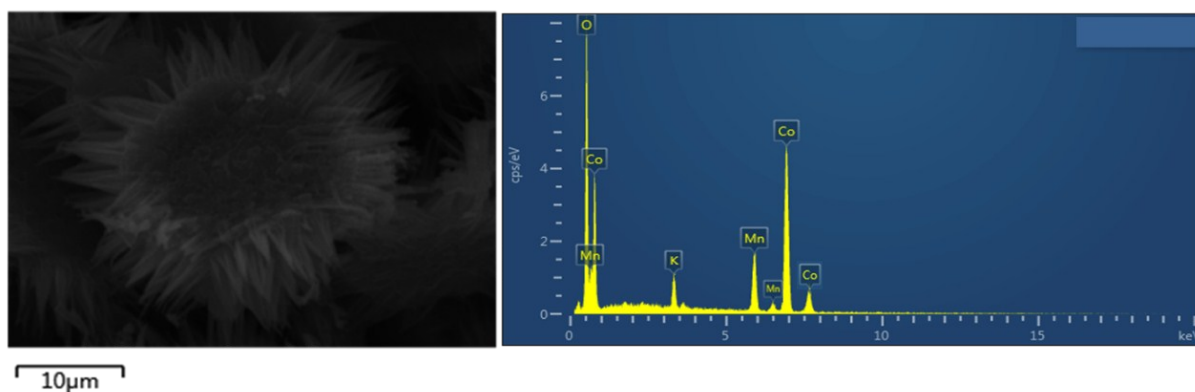


Figure S28. EDS spectra by the spot-scan method from a whole single 3D hierarchical $\text{Co}_3\text{O}_4@\text{MnO}_2$ structure (E).

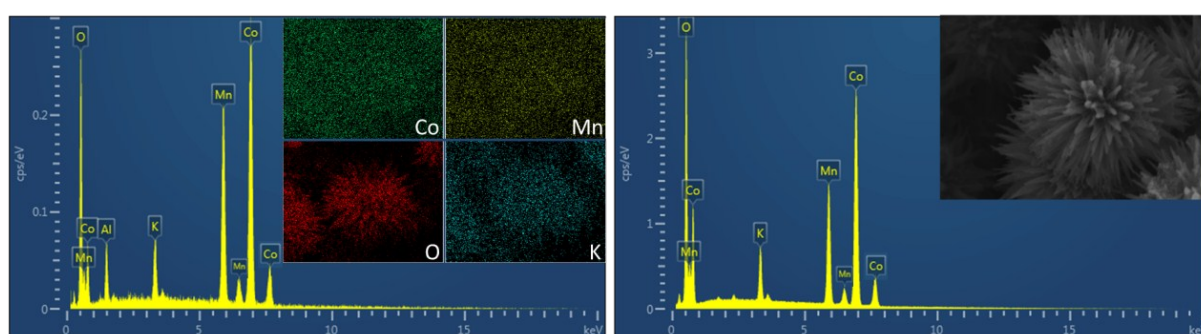


Figure S29. EDS mapping and EDS spectra by both the area-scan and spot-scan methods from a whole single 3D hierarchical $\text{Co}_3\text{O}_4@\text{MnO}_2$ structure (F).

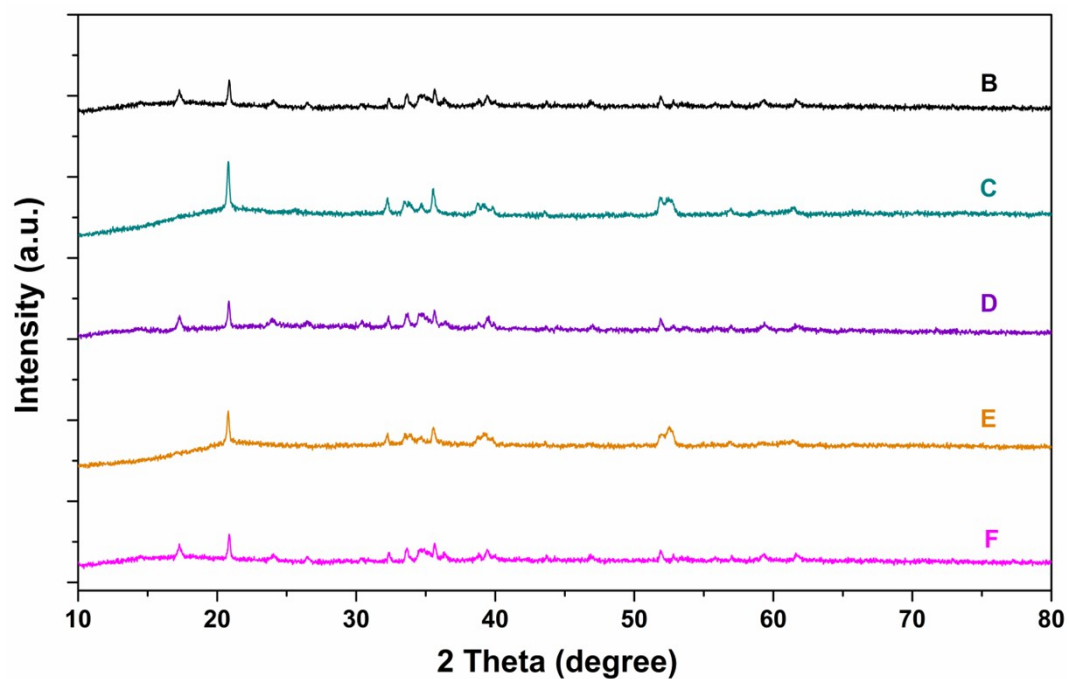


Figure S30. XRD patterns of the $\text{Co}(\text{OH})\text{F}$ precursors for the in-situ synthesized 3D hierarchical Co_3O_4 B-F materials.

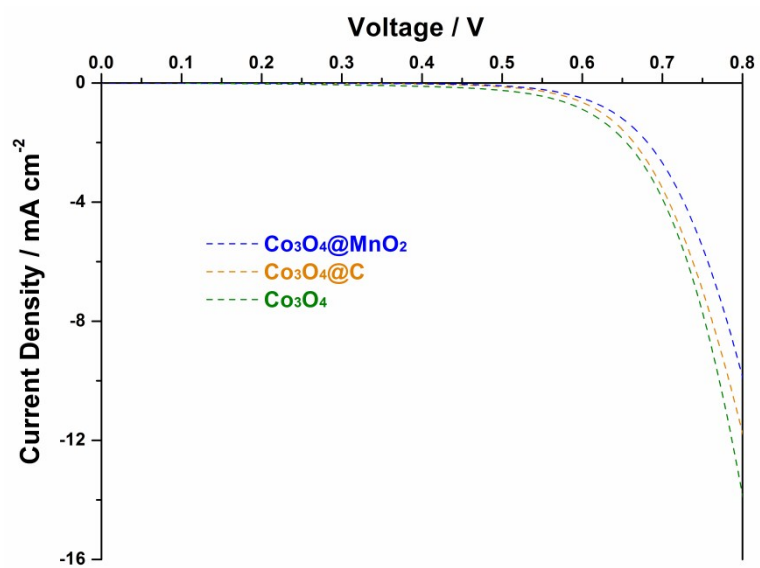


Figure S31. Dark I-V curves of the DSSCs based on Co₃O₄, Co₃O₄@C and Co₃O₄@MnO₂ counter electrodes.