Optimizing the Synthesis of Nanostructured $LiFe_xMn_{1-x}PO_4$ for Lithium Ion Batteries

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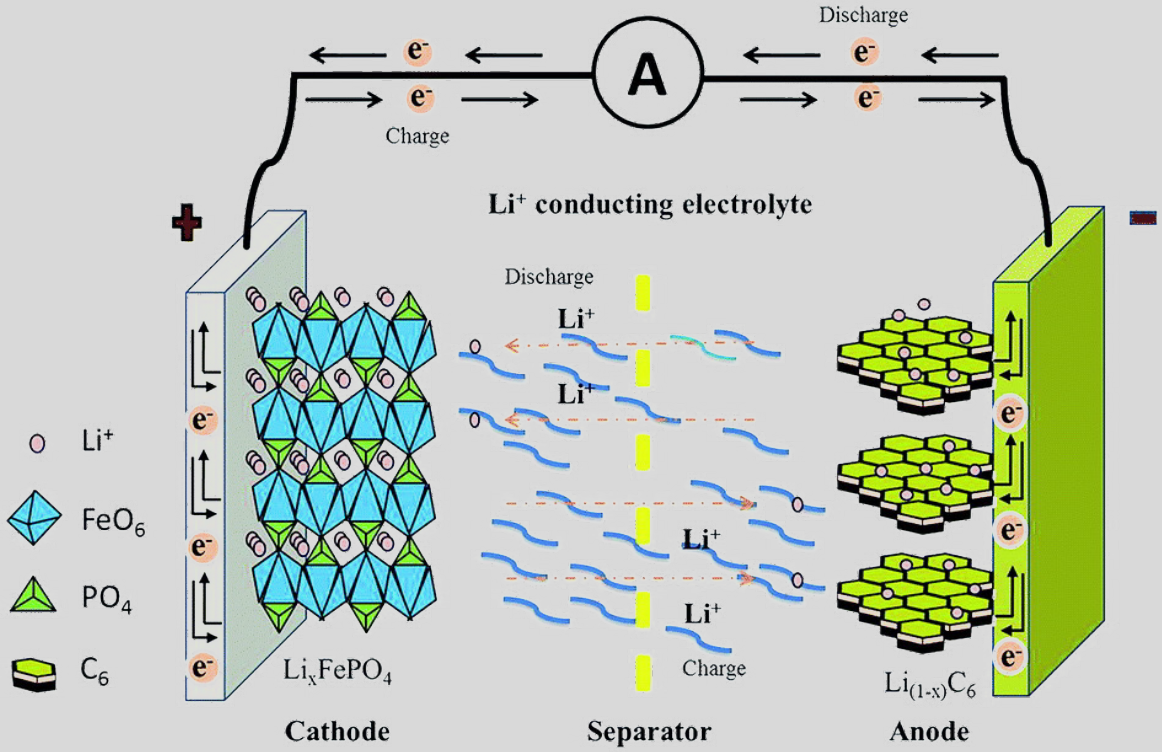
Effects of nanoparticles on lithium ion battery performance



Lee, H. A review of recent developments in membrane separators for rechargeable lithium-ion batteries; 2014.

Regularly-shaped nanoparticles will provide a lithium ion battery:

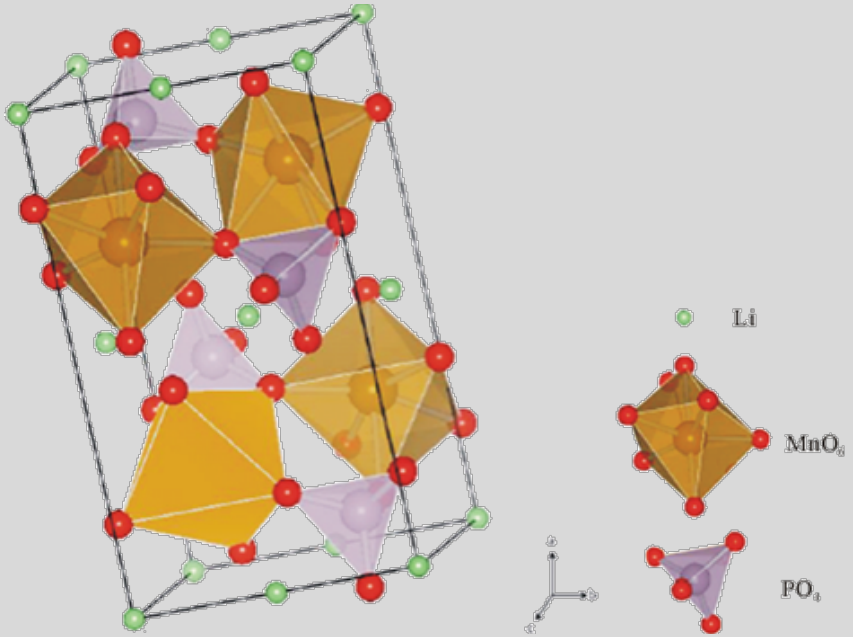
- high capacity at a high discharging rate[1]
- structural stability during cycling[2]

Lithium transition metal phosphates

Properties	$LiMnPO_4$	$LiFePO_4$
High energy density	■	■
Thermally stable	■	■
Environmentally benign	■	■
Low cost of raw materials	■	■
Optimal redox potential	■	■
High electron and ion conductivity	■	■

$LiFe_xMn_{1-x}PO_4$ as a cathode

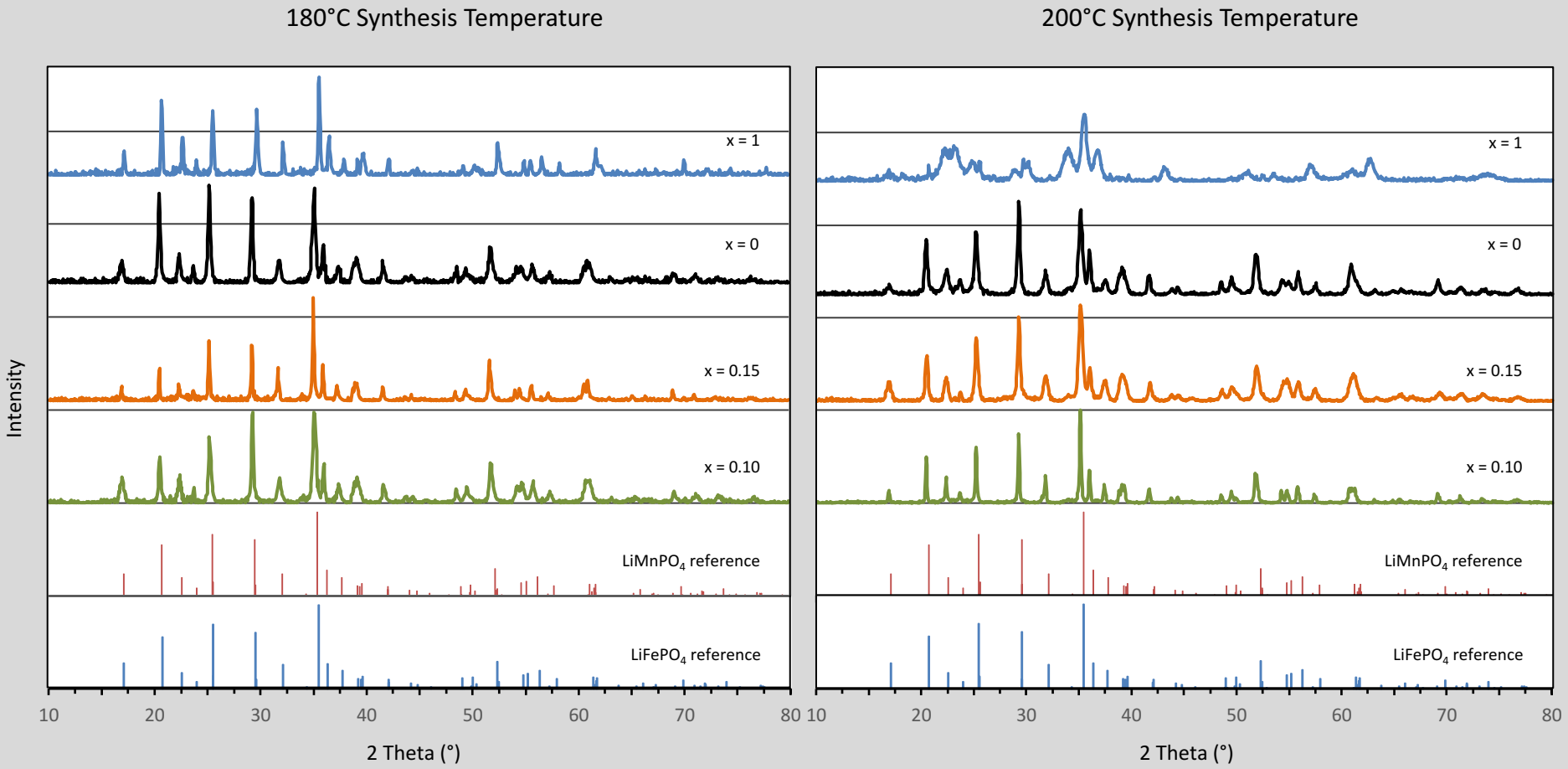
- Combining $LiFePO_4$ and $LiMnPO_4$ in the form of $LiFe_xMn_{1-x}PO_4$ has proven to combine the optimal redox potential of $LiMnPO_4$ the conductive properties of $LiFePO_4$ [7]
- Eight samples will be synthesized with varying x values and temperatures



Zaspel, C.E. Solution Contribution to the Electron Paramagnetic Resonance Linewidth in the Two-Dimensional Antiferromagnetic; 1995.

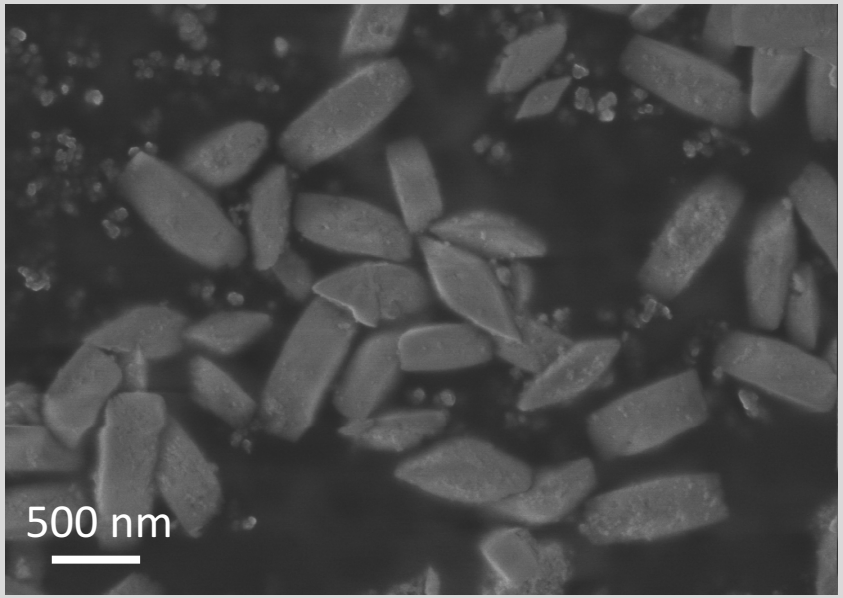
Results

Phase information

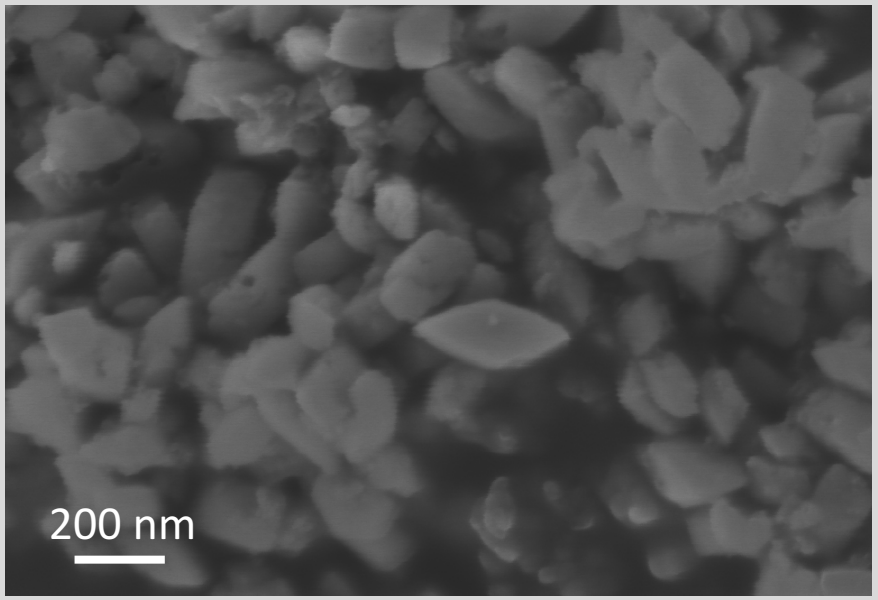


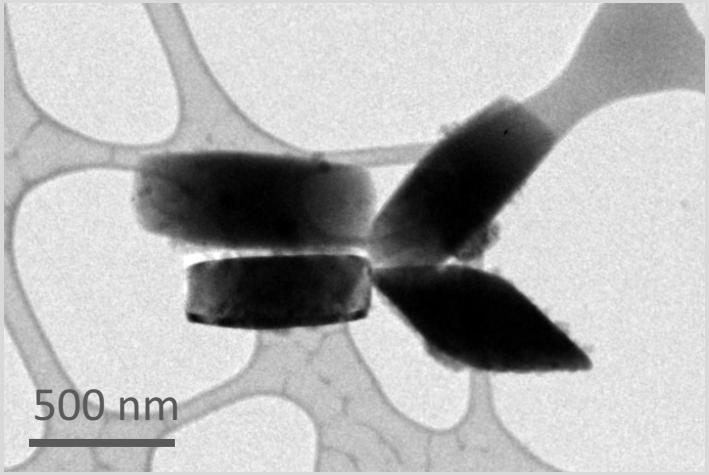
$LiFe_{0.1}Mn_{0.9}PO_4$

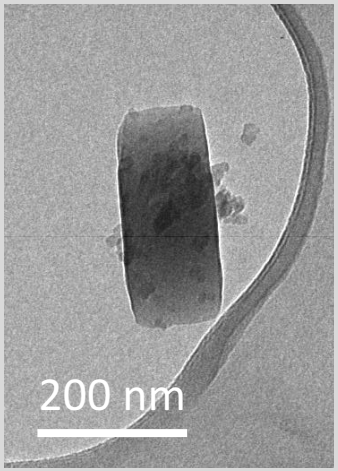
180°C

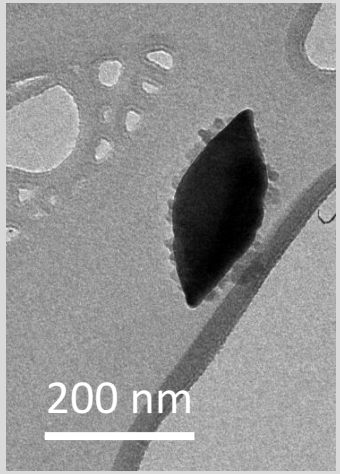


200°C



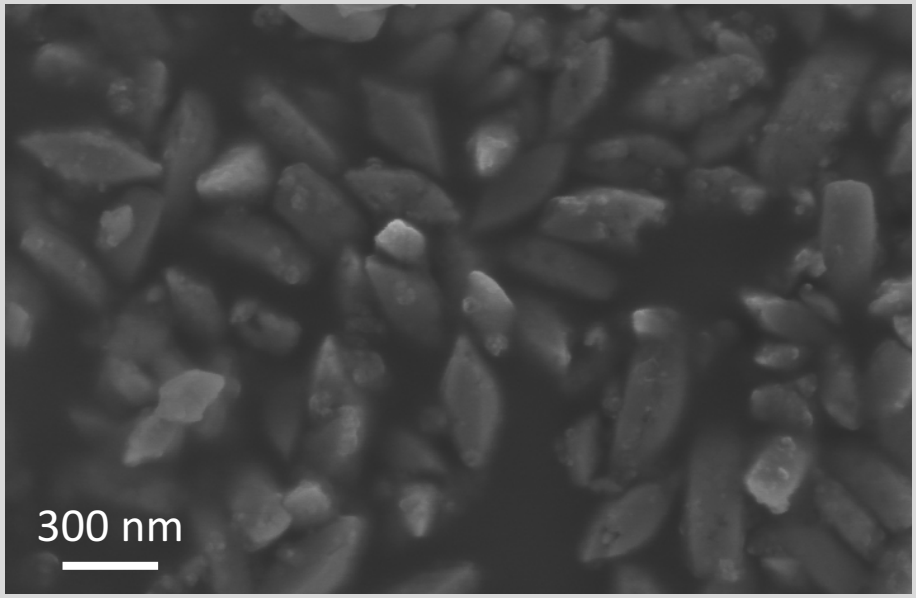




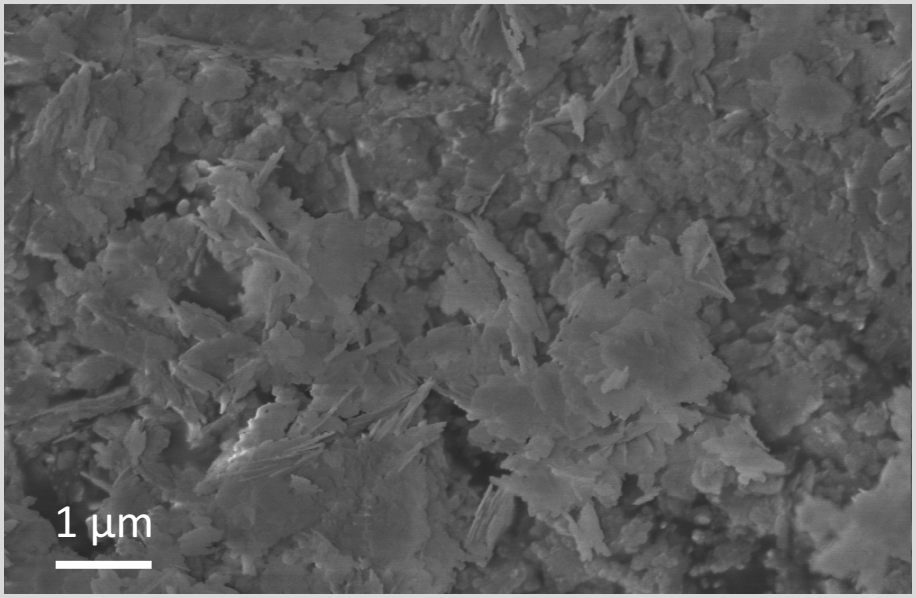


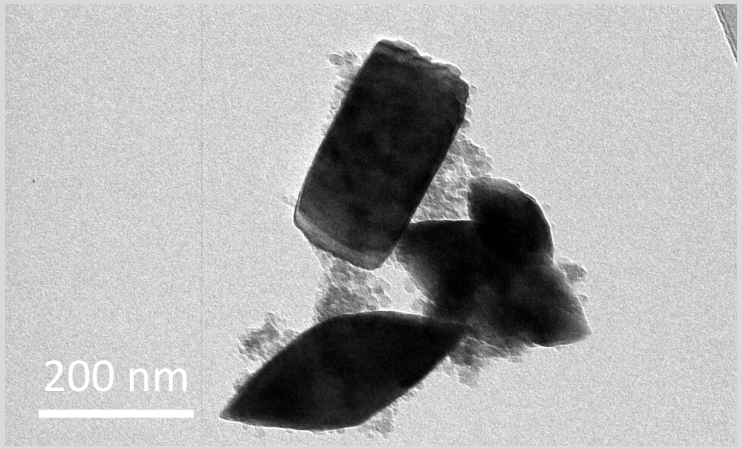
$LiFe_{0.15}Mn_{0.85}PO_4$

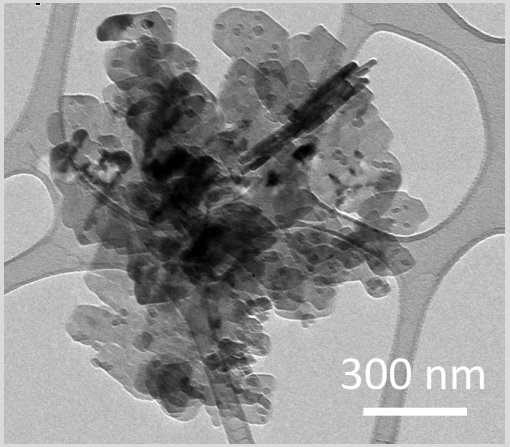
180°C



200°C

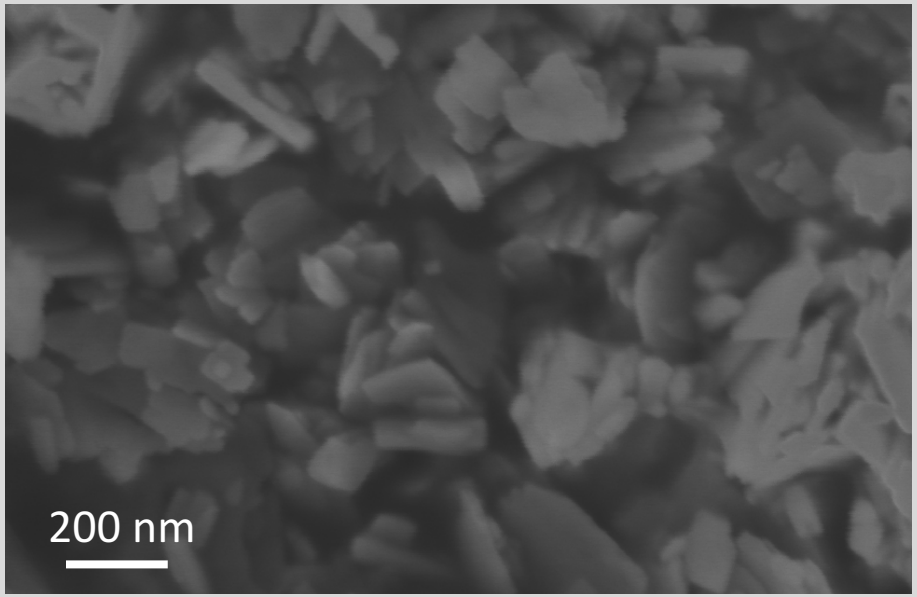




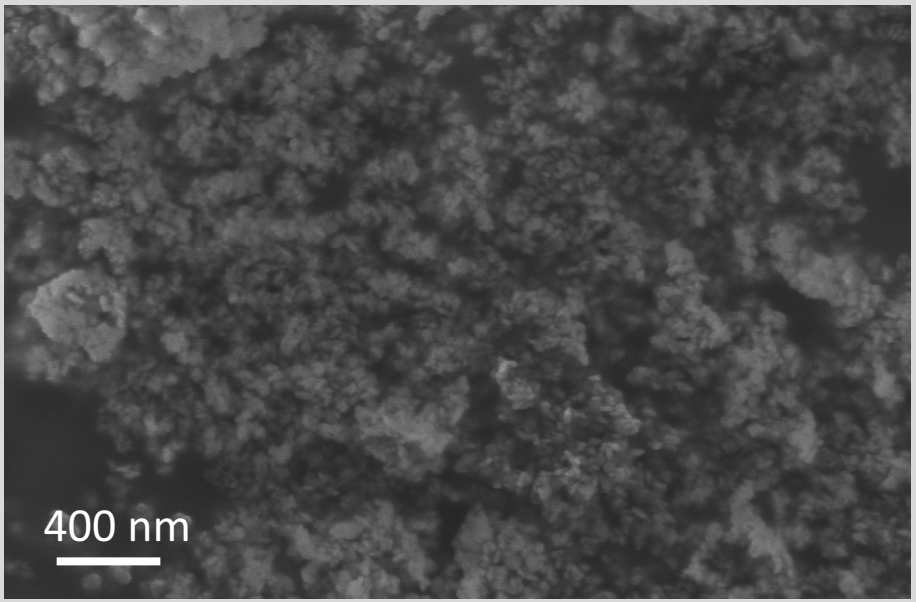


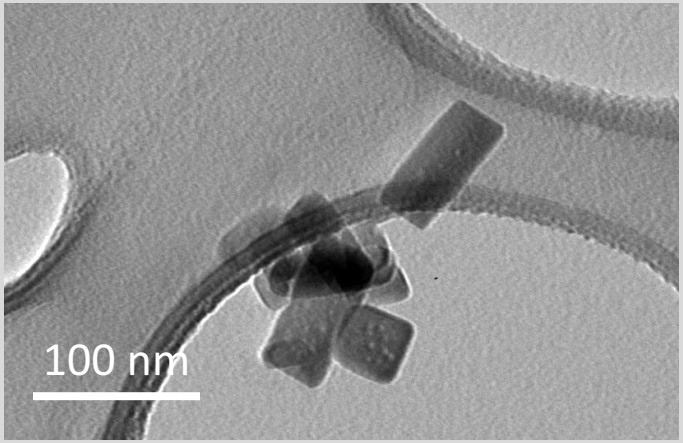
$LiMnPO_4$

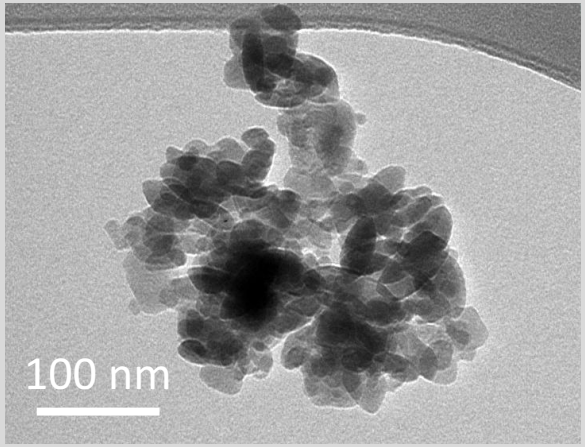
180°C



200°C



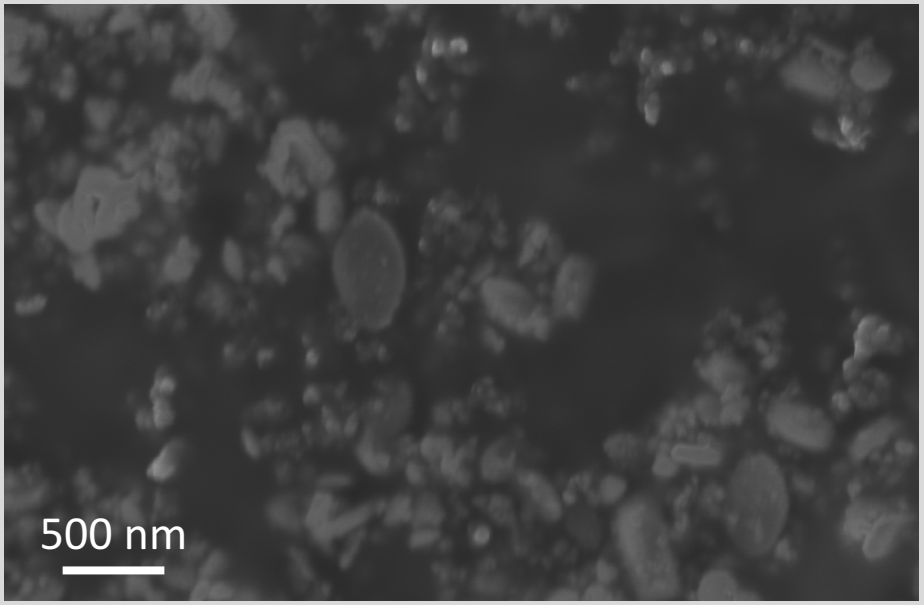


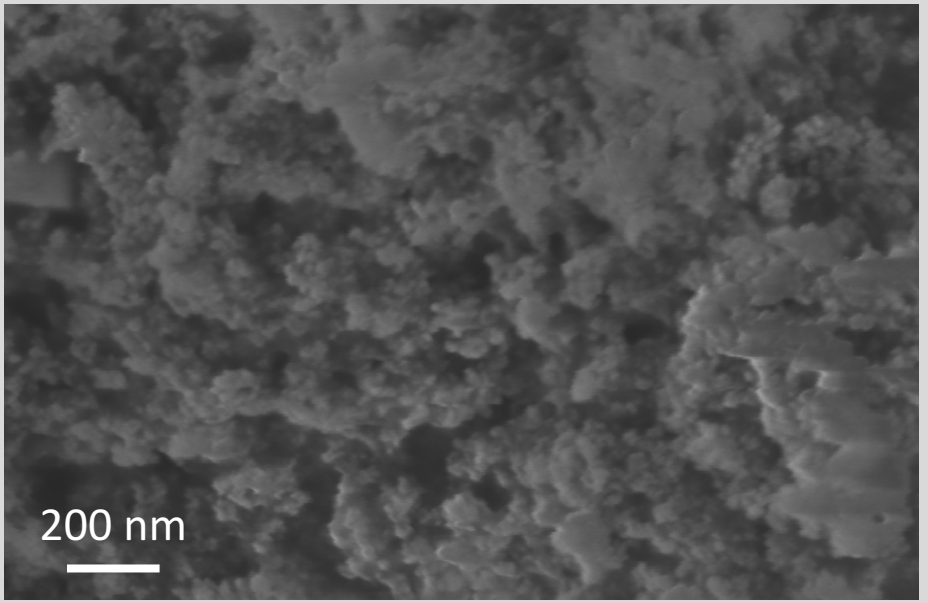


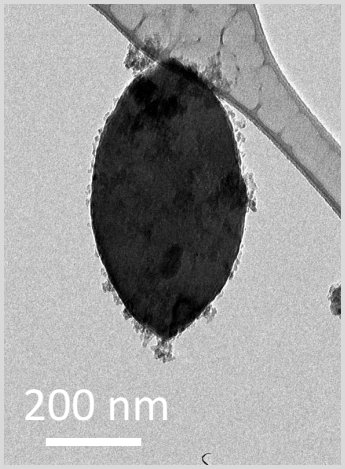
$LiFePO_4$

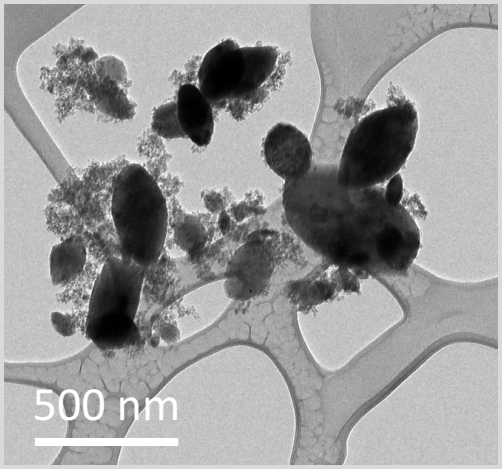
180°C

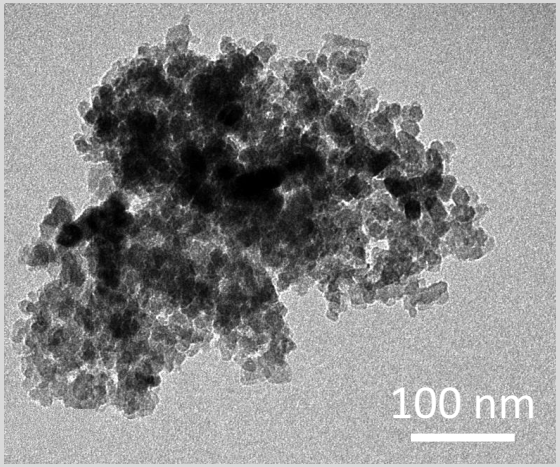
200°C











Conclusions

$LiFe_xMn_{1-x}PO_4$	180°C	200°C
x = 0.10	500 – 700 nm particle size rectangular front, rhombus side	300 – 400 nm particle size rectangular front, rhombus side with irregularities
x = 0.15	300 – 400 nm particle size rectangular front, rhombus side	inconsistent particle size irregular flakes
x = 0	50 – 500 nm particle size thin plates with inconsistent surface shapes	inconsistent particle size irregular thin plates
x = 1	100 – 500 nm particle size mix of shapes	inconsistent particle size amorphous incorrect phase

Acknowledgements

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NUANCE
Atomic and Nanoscale Characterization Experimental Center

SHyNE
Soft and Hybrid Nanotechnology Experimental Resource

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