Impact of Electrode Surface/Volume Ratio on Li-ion Battery Performance

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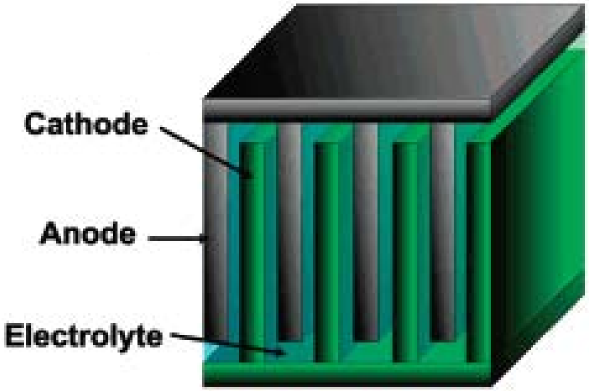
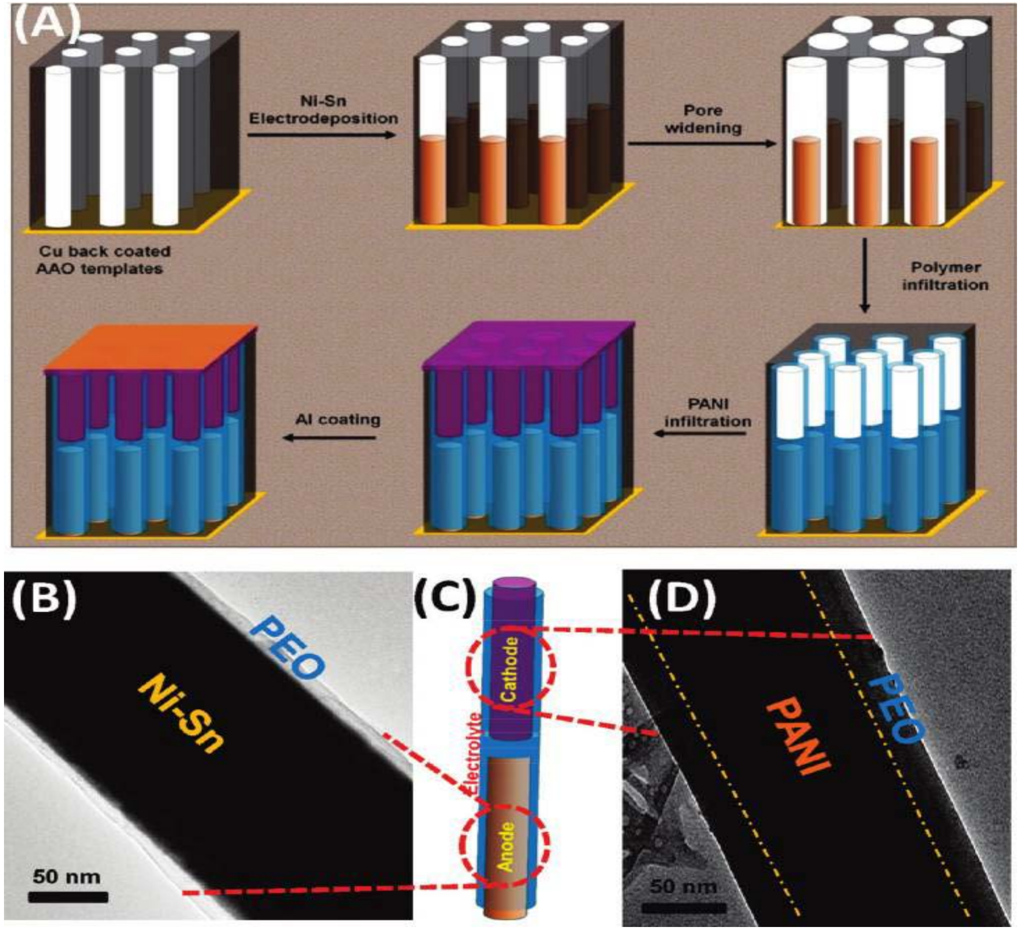
Introduction

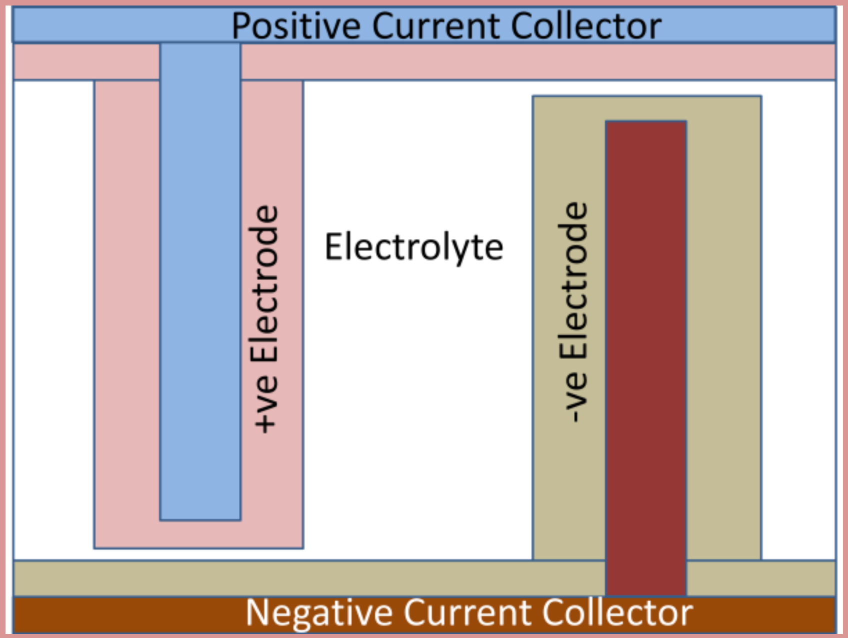


[1] Long, 2004

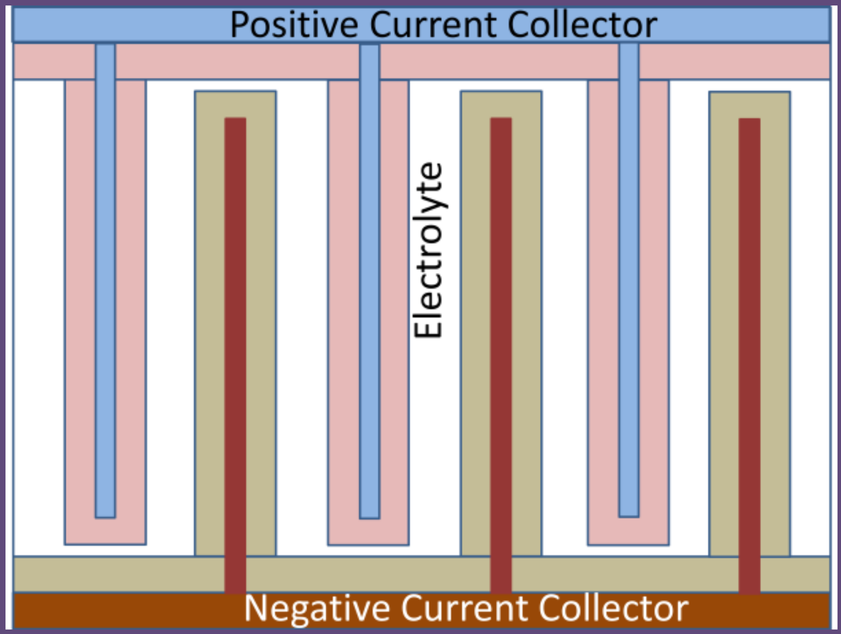


[2] Gowda, 2011

Simulation Structure



Normalized Electrode Surface/Volume Ratio (ESVR)=1

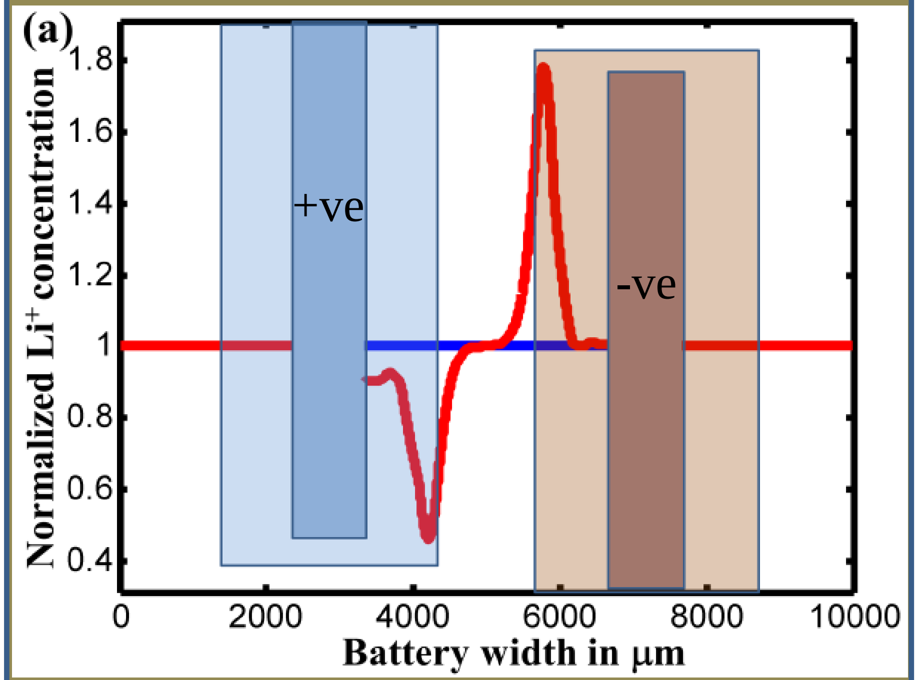


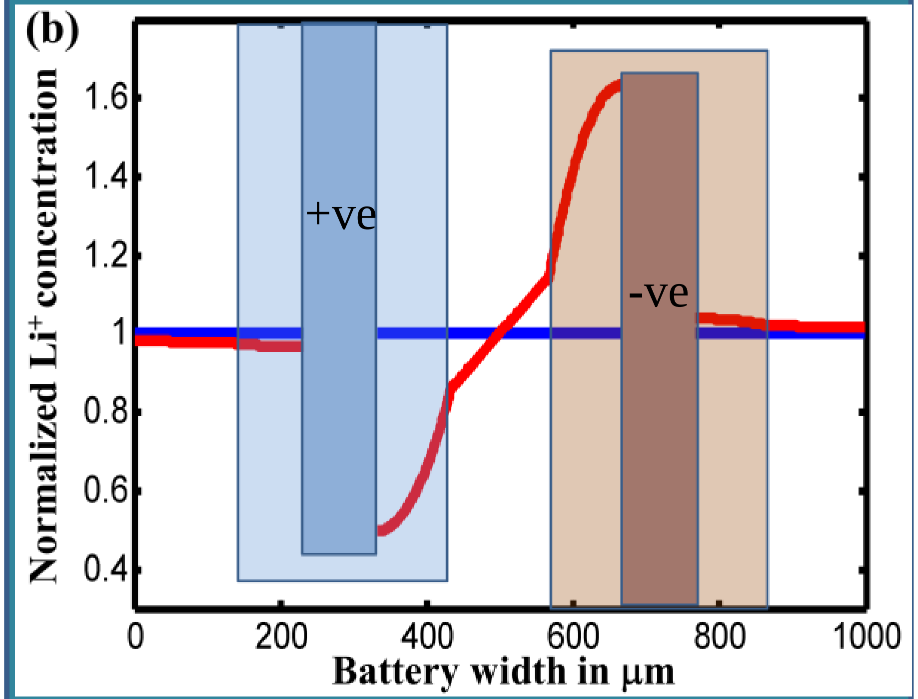
Normalized ESVR=3

-ve electrode→Carbon +ve electrode→ $LiMn_2O_4$

Electrolyte →1:2 EC:DMC (with 1.0 M $LiPF_6$ salt)

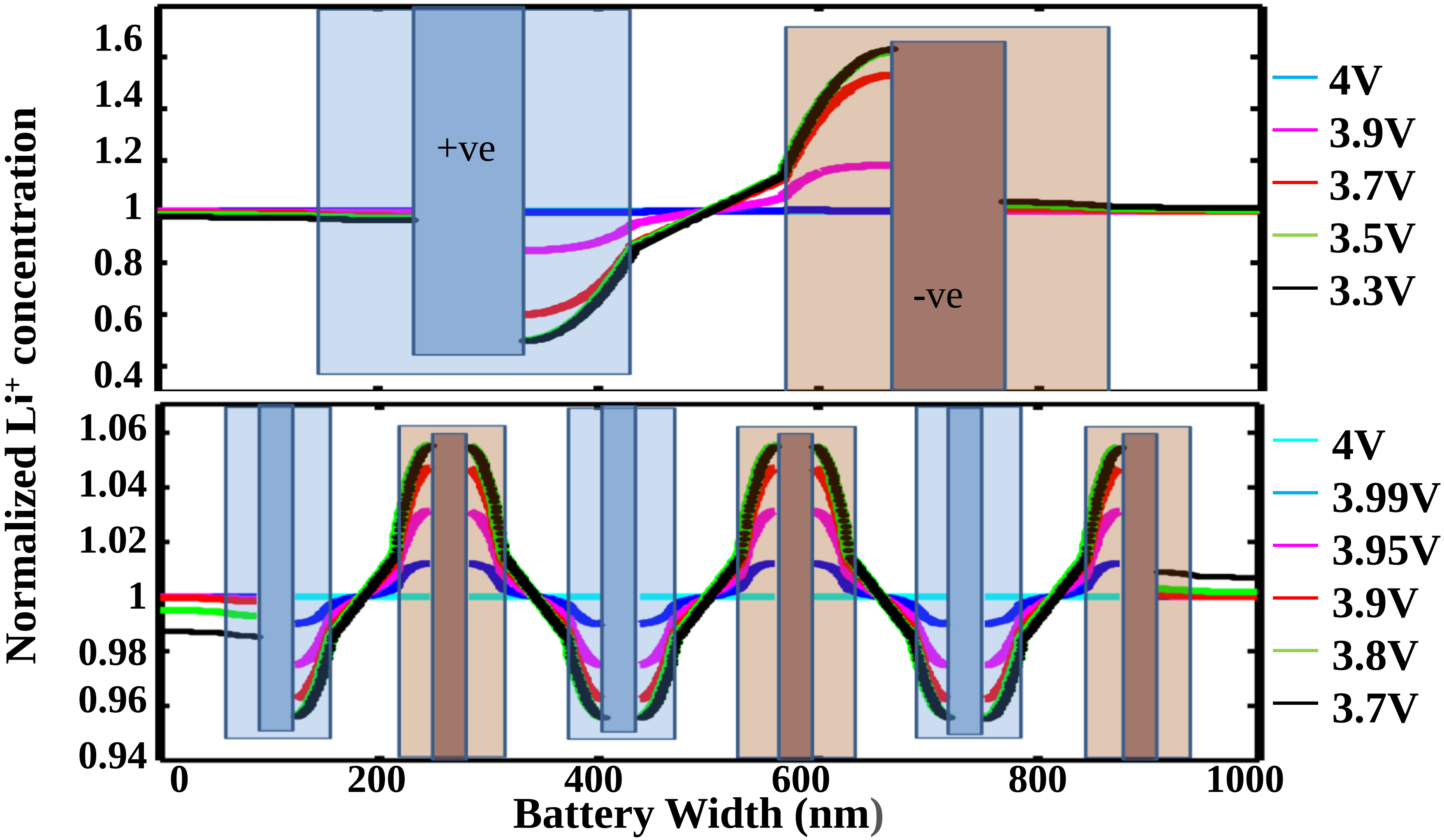
Simulation Results:



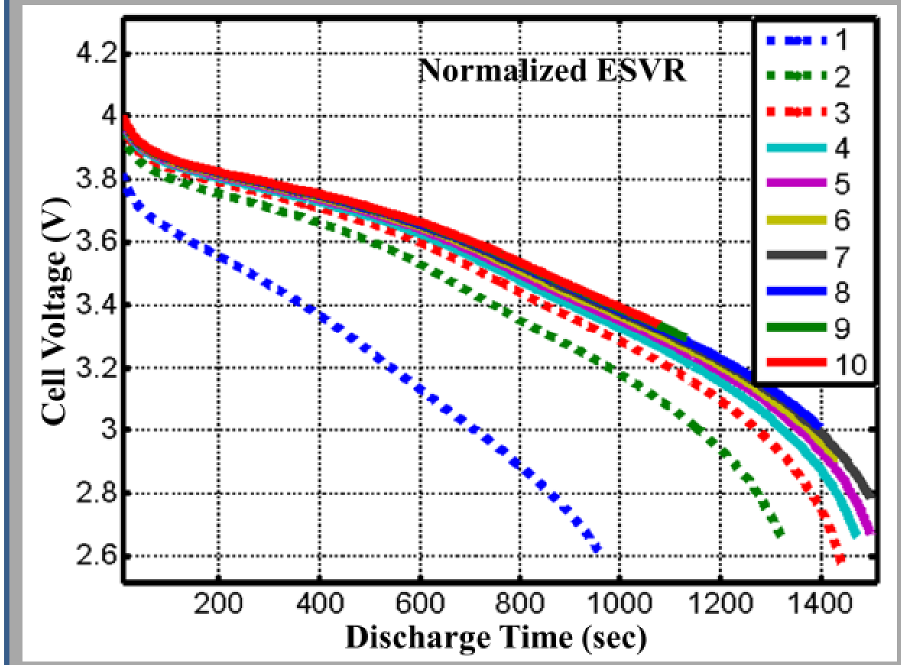


Normalized Li+ ion concentration during discharge process for different thickness of electrodes

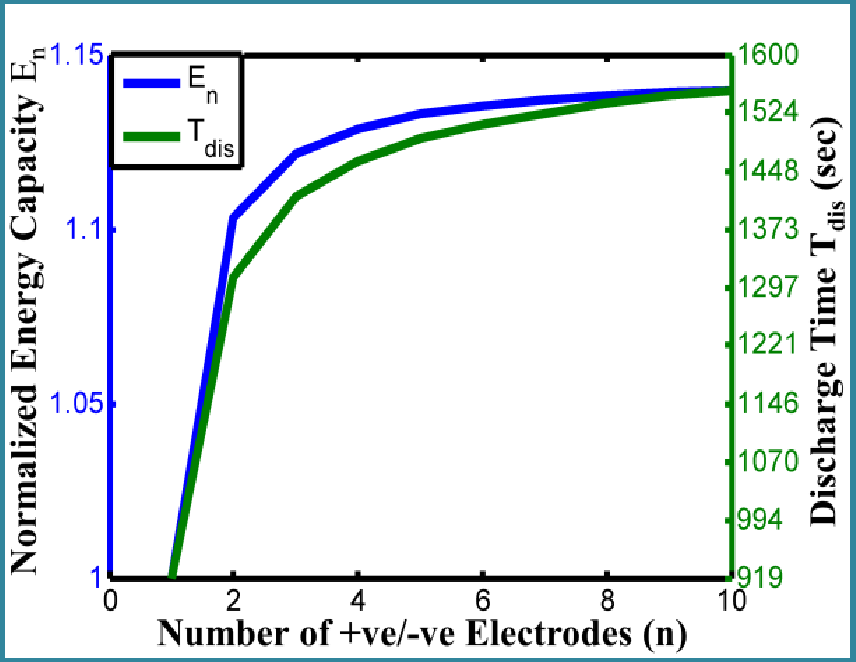
Normalized Li+ concentration for different pairs of electrodes during discharge process at various voltage levels.



Discharge and Energy Capacity

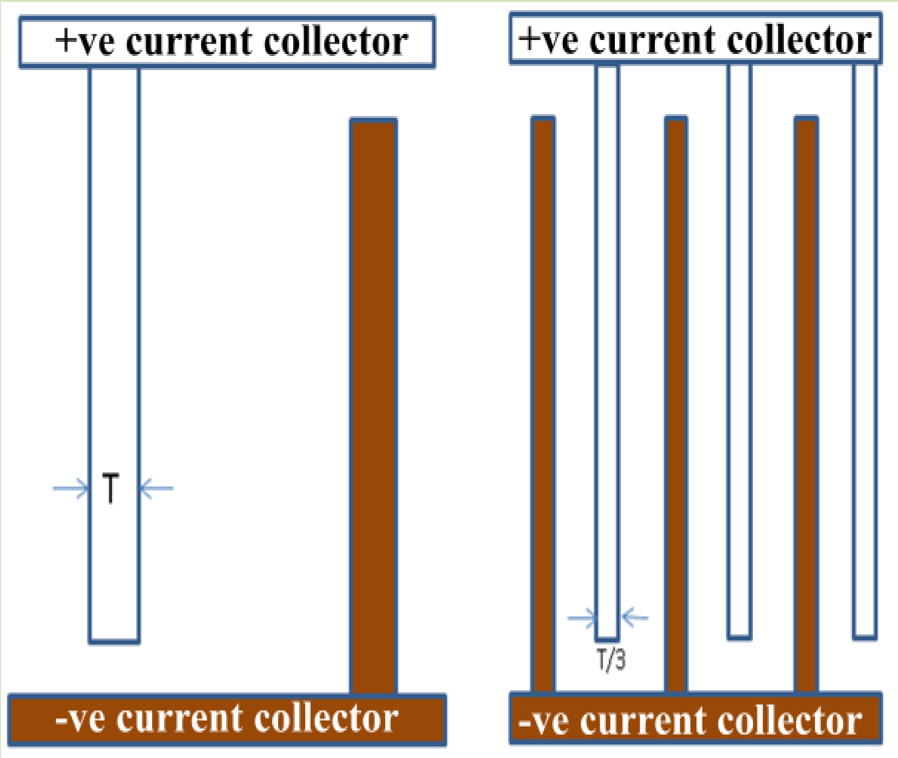


Discharge graphs for different normalized ESVRs



Normalized energy capacity and discharge time for different number of electrode pairs.

Thermal Model



Battery structures used for thermal modeling with pairs of current collectors

$$R^{+} = \rho^{+}\frac{L}{WT} \qquad R^{-} = \rho^{-}\frac{L}{WT}$$

$$P = I^{2}R^{-} + I^{2}R^{+} = I^{2}R$$

ρ^{+} Resistivity of +ve current collector

ρ^{-} Resistivity of -ve current collector

L,W,T Length width and Thickness of current collector

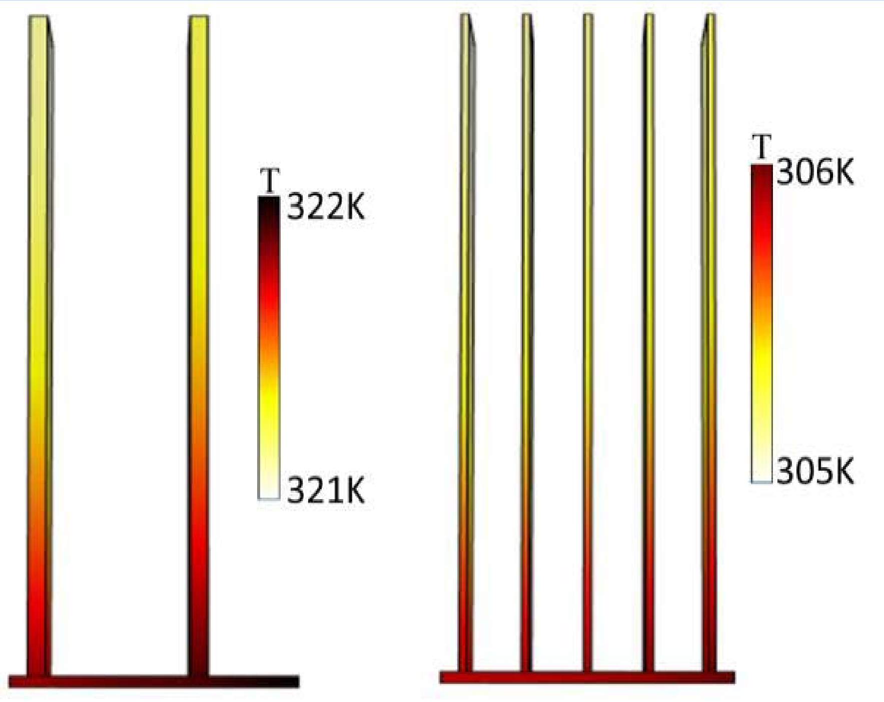
With n pairs of electrodes thickness $= T/n$

Current through each electrode $i = I/n$

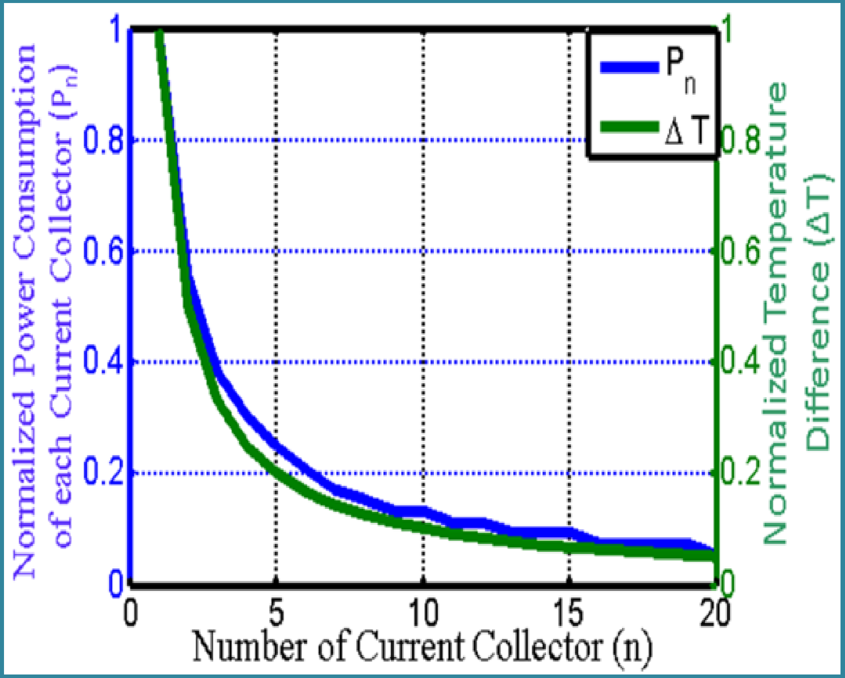
Power consumption by each current collector is

$$p = (I/n)^{2}nR = P/n$$

Power Dissipation and Temperature Distribution



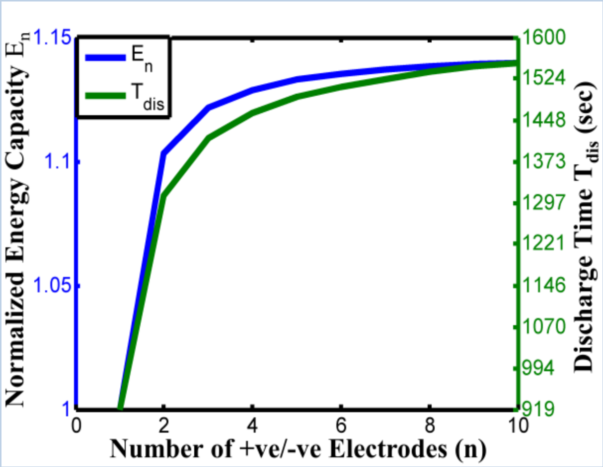
Temperature distribution of negative current collectors in battery pairs of electrodes with the same total current.



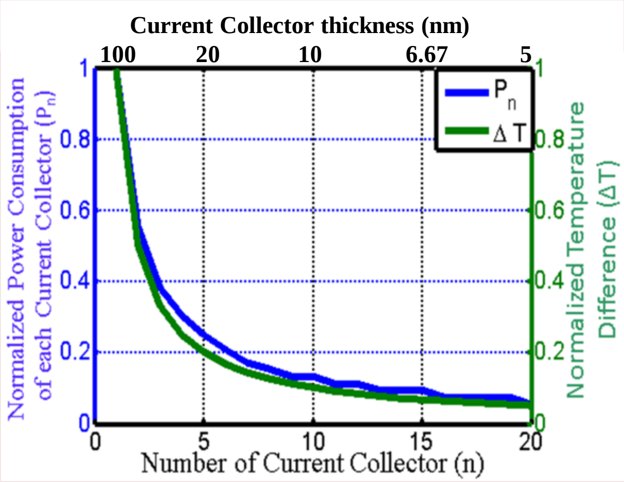
Normalized power consumption of each current collector, and normalized temperature versus the number of current collectors.

Conclusion

- With the Increase in number of electrode pairs increases energy capacity but it saturates after a certain number



- With the Increase in number of current collector power consumption by each of them decreases as well as the temperature of it.



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