

# Engineering Hybrid Nanostructured Composites as Active Materials in Lithium Secondary Batteries

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Nanostructured active materials investigated in lithium secondary batteries have been observed to effectively improve the capacity, stability and rate behavior.  $V_2O_5$  aerogel reached a very high capacity of ~400 mAh/g owing to its unique nanoporous structure [1].  $SnO_2$  made in nanofibers showed not only high capacity (> 700 mAh/g), but also excellent stability and rate capability [2]. By dispersion of electroactive tin in sub-Armstrong range, much improved cycling stability was achieved in Fuji's TCO glass [3]. We report here on three designed hybrid nanostructures in order to improve the performance of active materials. They are

**Structure a:** Coating a thin layer of conductive material on active materials

**Structure b:** Dispersing active materials in a conductive matrix

**Structure c:** Coating active materials on carbon blacks and polymer electrolyte-grafted carbon blacks

**Structure a** was employed for transition metal phosphates, which were investigated as cathode materials in lithium batteries. But because of their very poor conductivity,  $Li^+$  can only be partially extracted/inserted. Therefore, the purpose of coating a conductive layer on these phosphates is to reduce electronic resistance and improve current collect efficiency.

**Structure b** was used for Sn-based anode materials, in order to improve their cycling stability by hindering active tin from aggregation to form metal tin.

**Structure c** was applied for  $V_2O_5$  xerogel. Using sol-gel technique, we coated it on carbon blacks and polymer electrolyte-grafted carbon blacks.

Details of preparation methods, electrochemical results including charge/discharge profiles, rate behavior, and cycling stability, and physical characterizations (XRD, SEM and TEM) of above nanostructured composites will be presented.

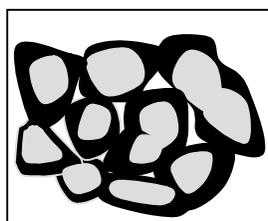
## Reference:

[1] F. Coustier, J. Hill, B. B. Qwens, S. Passerini, and W. H. Smyrl, *J. Electrochem. Soc.*, **146**, 1355 (1999)

[2] N. Li and C. R. Martin, *J. Electrochem. Soc.*, **148**, A164-170 (2001)

[3] Y. Idota, T. Kubota, A. Matsufuji, Y. Maekawa, and T. Miyasaka, *Science*, **276**, 1395 (1997)

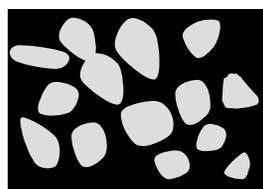
## Schematic illustrations of designed nanostructures



Black: Conductive materials coating

Grey: Active material

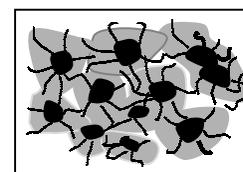
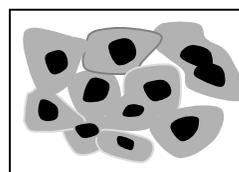
**Structure a:** Coating a thin layer of conductive material on active materials



Black: Conductive matrix

Grey: Active material

**Structure b:** Dispersing active materials in a conductive matrix



Black: Carbon black

Grey: Active material

Curves: Polymer electrolyte

**Structure c:** Coating active materials on carbon black or polymer electrolyte-grafted carbon black