



## **„Materials – The Technology Barrier to Advanced Batteries for Energy Storage”**

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Energy storage is the limiting technology for renewable energy, such as wind and solar, and particularly for the next generation of hybrid electric vehicles, the plug-in hybrid electric vehicle (PHEV). If long-lived, low cost and safe batteries or capacitors are to be developed, the materials limitations must be overcome. Intercalation is the predominant reaction mechanism in rechargeable batteries in use today. Intercalation processes, unlike conversion reactions, allow for fast ionic motion on both lithium insertion and lithium removal. Moreover the structural maintenance during reaction permits essentially unlimited cycling of the material. Intercalation can occur within a single phase as originally demonstrated in vanadium diselenide, the manganese oxide spinels and most recently in the lithium iron phosphate olivine. Although two-phase reactions were thought to be rate-limiting, such is not necessarily the case with the phosphate finding extensive use in hybrid electric buses.

This presentation will discuss the present status of materials, both bulk and nano, for the next generation of batteries, with an emphasis on the cathodes for lithium-ion batteries both high rate and high capacity, such as vanadium compounds.