Hierarchical assembled nanostructured electrodes for post Li-ion batteries

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Lithium-ion battery (LiB) is currently the most mature and widely used technology in the market. Optimizing the storage properties of batteries requires the search for new materials that offer specific capacities superior to current materials. The incorporation of nanomaterials with high specific capacities has proven to be an effective method for improving the electrochemical performance of LiBs.[1]
Transition metal dichalcogenides (TMDs) are potential candidates for applications in energy storage due to their layered structure (with the general formula MX2, where a layer consists of a sheet of transition metal atoms (M) bonded to two adjacent sheets of chalcogen atoms (X = S, Se or Te)), high surface area and electrochemical properties.[2] Depending on the chemical composition, TMDs can be used either as cathode or anode materials, exhibiting theoretical specific capacities higher than the commercially available graphite anodes or transition layered metal oxides.[3] Additionally, their large interlayer van der Waals gaps allow the intercalation of Li ions in the structure alleviating the large volume expansion present in alloying-type materials. However due to their low electronic conductivity, their cycling performances are poor.[4]
The present work explores a promising and original approach for implementing and developing a new bottom-up technique for hierarchical hybrid nanostructured electrodes based on vertically aligned carbon nanotubes (VACNTs) decorated with TMD nanomaterials. The functionalization of VACNTs by TMDs offers an unprecedented opportunity for their use in energy storage devices. These hierarchical architecture electrodes, due to their unique combination of redox chemistry, rapid ionic-transport channels, short-distance interactions between charge carriers, as well as between carriers and ions, and their earth-abundance, will play a key role in the successful implementation in the area of post Li-ion batteries.

References

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