SYNTHESIS AND NANO-STRUCTURATION OF ENERGY STORAGE MATERIALS BY BALL-MILLING

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In the field of energy storage, ball-milling has emerged since the 1990's as a powerful technique for the nano-structuration of different phases allowing an enhancement of their performances and a convenient method for the synthesis of new phases.[1] This presentation will focus on two main applications: hydrogen storage materials and electrode materials for Li-ion batteries.

For hydrogen storage, ball-milling is a simple method for preparing nano-structured powders with enhanced hydrogen absorption/desorption kinetics. This has been largely applied, for instance, to magnesium, for which ball-milling leads to the formation of grains boundaries acting as hydrogen diffusion paths. The ball-milling of Mg with suitable catalysts has allowed the development of composite materials, which are very interesting for hydrogen storage applications.[2] The reactive ball-milling under different gases is also very interesting. Ball-milling under hydrogen appears as a very convenient synthesis method for metallic hydrides.[3] Similarly, ball-milling under other gases can be conducted: for example, metal amides such as $LiNH_2$ or $Mg(NH_2)_2$ are easily prepared by ball-milling of the corresponding metals under ammonia.[4] The preparation of various hydrogen storage materials by ball-milling will be discussed as well as their hydrogen storage performances.

For electrode materials, ball-milling is often used for the electrode preparation by mixing the electro-active material with carbon and other additives. Ball-milling allows at the same time a decrease of the particles size of the active material and an intimate mixture with the conductive carbon.[5] Thus, the electrochemical performances are much better than the pristine material. More recently, the preparations of phases usually obtained under high pressure/high temperature conditions have been reported by ball-milling. We will especially discuss about the synthesis of superdense graphite intercalation compounds (LiC_3 with a Li content twice that of the classical LiC_6 phase),[6] the single phase LiSi,[7] and a new family of electro-active phases: $LiMSO_4OH$ with M = Fe, Co, Mn.[8] Ball-milling in liquid media can be also useful for the preparation of electrode materials: the addition of a solvent in the milling jar can prevent the particles agglomeration or, in some cases, the solvent can be used as a reactant. The presentation will make a review of the important inputs brought by the ball-milling method in the field of energy storage materials in the last few years.

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