Long-term Hydrogen Storage in Mg and ZK60 after Severe Plastic Deformation

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Long-term hydrogen storage experiments are discussed which were performed on MgH2 and on the Mg alloy ZK60 following prior Severe Plastic Deformation (SPD). Although SPD processing leads to significant enhancement of hydrogen absorption and desorption rates in both materials, these are not necessarily stable with respect to repeated loading/unloading cycles. Cold Rolled (CR) MgH2, e.g., shows a reduction of capacity by 30% after 100 cycles. In contrast, in ZK60 (Mg-5Zn-0.8Zr) processed by High Pressure Torsion (HPT), both kinetics and storage capacity are stable for at least 200 absorption/desorption cycles.

Analysis starting from Johnson-Mehl-Avrami theory clearly suggests that in the case of CR-MgH2 nucleation is followed by growth of extended MgH2 domains leading to a gradual deterioration of hydrogen diffusion and storage/release characteristics. In the case of HPT-ZK60, however, practically no further growth occurs subsequent to nucleation thus allowing for permanently enhanced hydrogen diffusion and stable storage/release properties. These results can be understood in terms of the different density and stability of SPD-induced lattice defects acting as nucleation sites in both materials studied [1].