Hydrogen Storage in Li-doped Carbon Materials

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Introduction

Hydrogen Storage in carbon materials has been investigated already in the 1980ies. Storge capacities of approximately 0,5 wt% have been found at room temperature rising to about 8 wt% at liquid nitrogen temperature [1. In recent years large hydrogen storage capacities have been reported when using carbon nanomaterials. Theoretical considerations show that a maximum hydrogen uptake of 8 wt% could be achieved [2].

Besides ordinary graphite, there are several forms of tubular or fibrilous structures of carbon existing. According to Chen et al. [3] doping of ordinary graphite with Li-salts results in weight changes up to 20 wt% when heating the sample in a hydrogen containing atmosphere (H_2-purity 99.99 %). A more recent publication by Yang [4] found that a significant part of the weight gain was most probably due to uptake of water from impurities in the gas.

Experimental

Graphite samples have been doped with a mixture from $LiNO_3$ and Li_2CO_3 by ball milling them for at least 1 hour in ratio 1:7 and 1:19 with graphite (Merck). The resulting mixture was transferred to a small crucible and heated in a thermal balance to 800 °C for activation under an atmosphere of flowing hydrogen. Standard purity (H_2 content 99.999 %) and hydrogen specially dried by diffusion through a Pd-membrane od assing through a liquid nitrogen filled cold trap was used for these experiments. Furthermore, nitrogen and argon have been investigated.

After activation the mixture was cycled between room temperature and 600 °C at a heating rate of 5 k/min. Additionally, quasi steady state experiments were carried out at different temperatures.

Results

Significant weight changes could be observed in dynamic experiments when using graphite. MgO did not show any significant effect (Fig. 1).

A large weight increase at temperatures of approximatley 20 wt% could be found when using untreated hydrogen. However, this value reduced to approximately 5 wt% when using extra dried gasses. The results of Yang [4] ascribing the most significant part of the weight effects to water uptake could be confirmed (Fig. 2).

Thermogravimetric experiments using nitrogen and argon also resulted in weight uptake during equilibration at 400 °C. However, the weight gain could not be removed by heating to 600 °C under these gasses. It proved to be necessary to switch to H_2 in order to remove the excess weight.

Figures

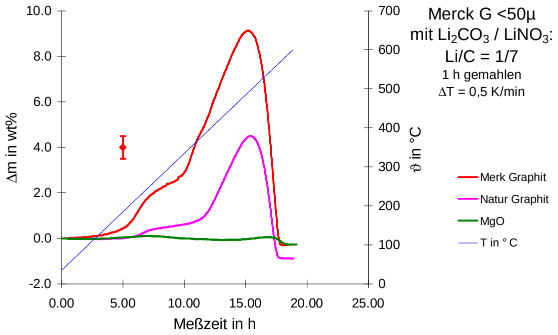

Fig. 1: Thermogravimetric analysis of different substrates

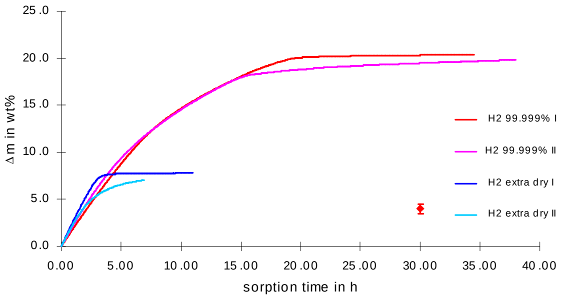

Fig. 2: Weight change of Li-doped graphite sample under hydrogen.

Acknowledgement

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Literature

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