

Hydrogen Recycling in CVD Processes

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Today, the demand of hydrogen is increasing throughout industries and energy-sectors. In photovoltaics and semiconductor industries hydrogen is often used as carrier gas especially in coating and epitaxy processes. Despite large amounts of estimated 16.5 million Nm³/year emitted solely from semiconductor epitaxy in Europe, an efficient use by recycling of hydrogen is not implemented there [1].

In the past a feasibility study and profitability calculation for recycling of hydrogen from exhaust gas by means of electrochemical hydrogen compression (EHC) [1] was performed within the framework a predecessor project, funded by the German Ministry for Economic Affairs and Energy, grant number 0324135D.

Here, we demonstrate the first successful implementation of a prototype hydrogen recycling system in a SiC-APCVD plant [2], located at Fraunhofer ISE. The composition of the exhaust gas from the wet chemical scrubber was analyzed and fed to the recycling system. It could be shown that the HCl content of the exhaust gas after passing the wet scrubber is well below 1ppm and therefore well below potentially damaging concentrations of the EHC stacks. The hydrogen from the waste gas was successfully recycled at a rate of 75%.

For CVD processes, the used hydrogen needs to be of high purity. In most cases, hydrogen with 5N purity or better is passed through a purification, before it is used in CVD equipment. Especially an excess of oxygen containing residual gases can lead to detrimental effects of the coating. The measurement of gas phase impurities is challenging especially for high purity gases; therefore, we will also focus on the resulting film properties.

Accordingly, SiC layers are currently fabricated using recycled hydrogen. It is planned to characterize the properties of the grown films, especially the growth-rate, composition and impurities. A comparison with films grown without recycled hydrogen will be presented. The presented work demonstrates an important option to more sustainable and economical CVD processes.

References

- [1] Rochlitz L et al. Second use of hydrogen waste gas from the semiconductor industry – economic analysis and technical demonstration of possible pathways. *Int. J. Hydrog. Energy* 2019;6(31): 17168-17184.
- [2] Schillinger K, Janz S, Reber S. Atmospheric pressure chemical vapour deposition of 3C-SiC for silicon thin-film solar cells on various substrates. *J. Nanosci. Nanotechn.* 2011;11(9): 8108-8113.