Faculty of Electrical Engineering & Computer Science
Master Degree Course Electronics Engineering, MSc EE

HOCHSCHULE BREMEN
UNIVERSITY OF APPLIED SCIENCES

Master 2013

Mattias Kruskopf

Optimization of Growth Parameters and Characterization of Epitaxial Graphene on 6H-Sic.

ABSTRACT - Masterthesis

The PTB Braunschweig is investigating a new generation of quantum Hall effect (QHE) devices based an epitaxial graphene on silicon carbide which are promising candidates to replace the actual resistance standard. The greatest challenge in achieving this goal is to obtain graphene material that matches with the high requirements of metrological applications. This thesis presents experimental results about the growth and characterization techniques of epitaxial graphene on silicon carbide substrate based on state of the art knowledge and technology. The graphene samples have been processed in a graphene reactor that was recently installed at the PTB. The analysis of the growth behaviour starts with the definition of a standard set of process parameters and focuses on the improvement of the process. This involves detailed characterization of the material quality using atomic force microscopy, Raman spectroscopy, scanning electron microscopy and electrical measurements.

Close correlations between the growth behaviour and critical parameters such as substrate properties, process time and process temperature have been identified and described in detail. Preparation of the substrate material by hydrogen etching at 1400˚C and subsequent growth of graphene at 1700˚C for 15 minutes in an argon atmosphere was determined to result in completely covered graphene samples. A graphene reference sample from a well known research team showed better but still comparable results that are discussed in detail and imply approaches for further improvements. Especially the characterization of the electronic transport properties by means of the sheet resistance- and Hall measurements in the van der Pauw setup showed that the electrical properties are already at the same level as reported in recent publications. Furthermore, the results demonstrate that the applied characterization methods are suitable to precisely distinguish differences in the graphene layers on the micrometer scale using Raman spectroscopy and even an the nanometer scale by means of AFM and SEM measurements. The best samples that were obtained by the optimized graphene process are already suitable to start with the testing of small scale graphene devices which represents the next step towards high accuracy QHE measurements.