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During my staying at the Technical University of Dresden I was developing my skills of investigation of the electrical properties of gold (Au) and its complexes with hydrogen in n- and p-type Si by means of the DLTS and high-resolution Laplace DLTS techniques.
For the realization of this task n- and p-type Si samples doped with Au were hydrogenated by wet chemical etching or by a dc H plasma treatment. During the wet chemical etching the mixture of HF:HNO3:CH3COOH with a ratio of 3:5:3 (CP4A) was used. The first couple of days were used to get familiar with the procedures of the hydrogenation of semiconductors. Different conditions of the wet chemical etching (time and temperature) and a dc H plasma treatment (time, temperature, accelerated bias) were tested in order to find the most effective way of the hydrogen introduction. Both DLTS and Laplace DLTS require good quality Schottky and ohmic contacts in order to obtain reliable results. In this particular case, I learned the method of fabrication of Schottky contacts by thermal evaporation of Au on n-type Si and Al on p-type Si. Ohmic contacts were prepared by rubbing an eutectic InGa alloy onto the backside of the sample. The quality of the Schottky and ohmic contacts were checked by current-voltage (IV) characteristics at different temperatures. The rectifying contacts with a rectification ratio more than 10^4 were achieved at room temperature. The leakage current was less than 20 µA at -4 V for a diode with an area of about 2 mm^2.
I had an opportunity to further try my newly acquired skills in the lab I visited. The hydrogenation of Au-doped Si resulted in the appearance of five peaks (E90, E105, E155, E195, and E270) in n-type Si and five peaks (H105, H160, H205, H240, and H270) in p-type Si. We did not observe these peaks except E90 in hydrogenated Si without Au. The intensity of some peaks reduces towards the bulk of Si and this shows that they are rather linked with AuH_x complexes. The exact structure of these complexes should be established after the carefull analysis of the obtained data (depth profile, the activation enthalpy, the changes of the emission rate with electric field).