Hydrogen Response Mechanism of Pt-GaN Schottky Diodes

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Gas sensitive silicon metal-oxide-semiconductor (MOS) devices with catalytically active platinum gates show a selective sensitivity towards hydrogen in case of a thick continuous gate. Intensive research led to a model of the gas sensing mechanism which attributes the sensing mechanism to the formation of a H-induced dipole layer at the $Pd - SiO_2$ interface (Fig.1). The hydrogen dissociates on the Pt surface and is adsorbed mainly on surface and interface sites. The latter effect leads to a reduction in the Schottky barrier height (Fig.2) and thus to the hydrogen sensitivity of the device [1].

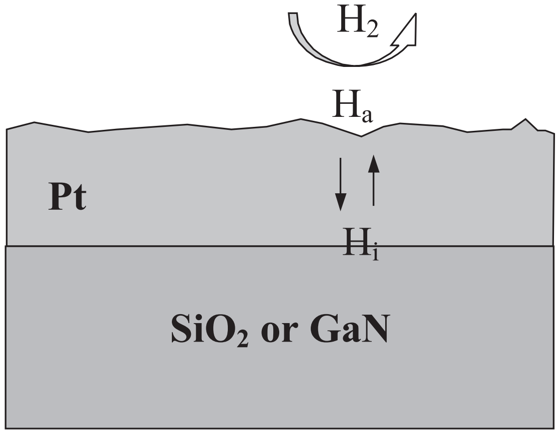

Fig. 1: H_2 Sensing mechanism of Pt-MoS devices and Pt-GaN Schottky diodes

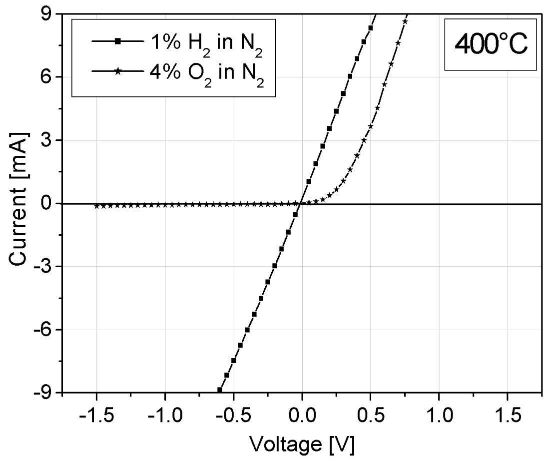

Fig. 2: I-V characteristics of a Pt-GaN Schottky diode after exposure to reducing or oxidizing gases

In order to allow higher operation temperatures devices based on wide-bandgap semiconductors were realized [2]. GaN based Schottky diodes with a Pt-Schottky contact showed a strong sensitivity to exposition to H_2 and D_2, respectively. The sensing mechanism is suggested to be similar to corresponding Si devices although no experimental evidence is given yet.

The ERD (Elastic Recoil Detection) method was used to measure the distribution of the absorbed gas. For the ERD measurement a 10 nm thick Pt layer was deposited on a low-doped GaN:Si single layer. The measurements were performed under a scattering angle of 18 deg using a 40 MeV ^{197}Au beam in order to reduce irradiation damage [3]. The scattered ions were detected using the QRD magnetic spectrograph with a position sensitive TOF (time of flight) detector. The depth resolution in this exper ment was 1 nm. D_2 was used as the active gas in stead of H_2 to distinguish between Hydrogen previously incorporated and the Deuterium incorporated during the exposure. No electronic difference was measured for the different Hydrogen isotopes. The sample was firstly put under vacuum and than exposed to D_2. Afterwards the sample was transfered into the measuring chamber without any further exposition to other gases. We could prove that hydrogen adsorbs mainly at the Pt surface and at the Pt-GaN interface (Fig.3). However the huge broadening of more than 10 nm of the Deuterium is contributed to the sample roughness and the inhomogenious Pt-layer. A much sharper profile is expected from smoother sample surfaces and interfaces.

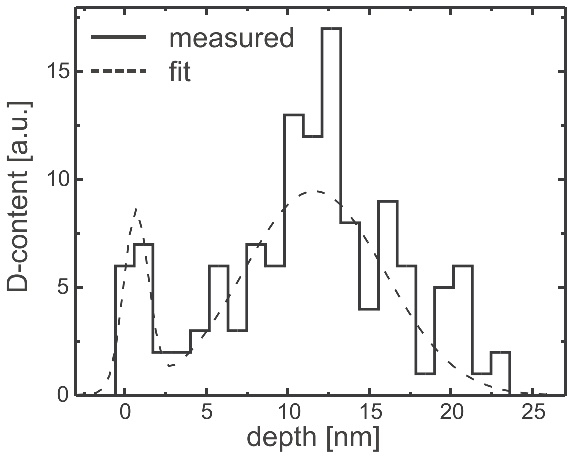

Fig. 3: H_2 Deuterium profile obtained by ERD at the surface of a Pt-GaN Schottky diode

References

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