Diamond detector preparation for high intensity beam monitoring and high precision T0 determination.*

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CVD diamond material has been extensively used for particle detection [1, 2]. This radiation hard material for detector application is of great importance for existing as well as for newly planned high intensity experiments. Besides radiation hardness there are other properties like: wide-band-gap, high breakdown voltage, high thermal conductivity, small dielectric constant, which are very attractive for detector applications. To take advantage of these properties, there is a need for reliable contacts between the diamond material and metal electrodes. As it was widely investigated, depending on applied preparation procedure, the metal-diamond interface can show either rectifying Schottky or low resistant ohmic characteristic (see for example [3]). For detector applications it is essential to obtain a homogeneous low resistance ohmic interface between diamond and metal. Failing this the charge created in the diamond material by ionizing particles can not be transported freely and gets blocked at the metal-diamond contact surface causing significant reduction of the effective electric field in the detector.

For the detectors discussed in this report scCVD diamond sensors with thickness of 300μm and size of 4.7 mm x 4.7 mm were used. The sensors were metallized with 50nm Cr layer followed by a 150 nm Au layer. It has been shown that the onset of the transition from a rectifying to an ohmic contact for Cr-diamond occurs between 580-620^{o}C when a first carbide phase is formed (Cr_2C) [4]. Following this measurement the typical annealing process for Cr-diamond ohmic contact should be conducted at temperatures above 650^{o}C for a period longer than 20 min. To avoid surface contamination during the high temperature annealing the procedure has to be conducted in the UHV chamber. The annealing of the metallized samples was performed at the DAISY-Fun facility (DArmstädter Integriertes SYstem für FUNdamentale Untersuchungen) at Technical University of Darmstadt. The metallized samples, after cleaning in ultrasonic bath, were installed in the vacuum chamber. At a vacuum of about 10^{-8} mbar the heater was started. The temperature was slowly increased, about 1^{o}C per 10 sec, keeping the vacuum better than 10^{-7} mbar. The sample was finally annealed at 780^{0}C for 20 minutes.

The annealed samples were investigated by means of a high intensity electron beam from S-DALINAC (Der supraleitende Darmstädter Elektronenbeschleuniger) at Technical University of Darmstadt. During the experiment a high quality electron beam, with energy of 70 MeV was delivered to the experimental area where the annealed diamond detectors were installed. The detectors were readout by a fast scope with histograming capability. In Figure 1 the ADC spectra are shown for very low intensity (2 kHz) and high intensity (10 MHz). The ADC spectra showed stable response of the detector independent of the beam intensity indicating a perfect ohmic character of the contact between Cr and diamond material. The tail in the bottom figure at large amplitude is due to particle pileup at such high rates.

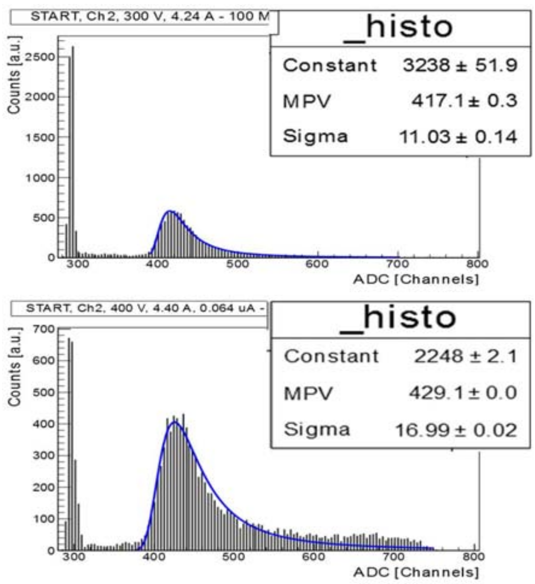

Figure 1: ADC spectrum measured at low electron beam intensity, about 2 kHz, - top picture and spectrum measured at high beam intensity, about 10 MHz, - bottom picture. The MPV values for both measurements stay at the same position indicating very stable detector operation.

References

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