Electrical conduction in heteroepitaxial CVD Diamond on Ir/YSZ/Si(001)

M.S.Rahman[1], E. Berdermann[1], S. Dunst[2], M. Schreck[2], M. Ciobanu[1], M.Traeger[1]
[1]GSI, Helmholtz Zentrum für Schwerionenforschung, D-64291 Darmstadt, Germany
[2]*Universität Augsburg, Institut für Physik, D-86135 Augsburg, Germany*

Diamond heteroepitaxy has been a field of intensive research within the last decade. In detail, the work was focussed on the selection of various substrates [1] and also on the search for appropriate nucleation [2] and optimized textured growth procedures. Recently, first promising results have been reported for diamond on iridium in terms of structural homogeneity, charge collection efficiency, and low dark current [3].

In this study we investigated the conduction mechanisms of several heteroepitaxial diamond films grown on Ir/YSZ/Si(001) by measuring the dark currents at various temperatures (room temperature to 673K) up to voltages of ± 1000V for various contact metals. Figure 1 shows the dark conductivity for a 230µm film. The *I-V* measurements on this sample were done under vacuum condition ($\sim 10^{-6}$mbar) after removal of the substrate and polishing on both sides. Ti-Pt-Au electrodes were deposited on both surfaces. The first intriguing feature of the present film is the very low absolute value of conductivity, which has to be interpreted against the background of the high density of dislocations still present in the film.

The activation energy was deduced from an Arrhenius plot as shown in Figure 2. We found a value of 1.46±0.002eV which is higher than recently measured for single crystals [4]. It is in the range of the activation energy of substitutional nitrogen (E^{ac}~1.7eV). It is also worth mentioning that the E^{ac} value is field independent.

Ti-Pt-Au metallization is known to form an Ohmic contact, and this behaviour is confirmed by the linear increase of I_{Dark} with V at low fields. However, we also analysed the data in terms of charge carrier emission over a Schottky barrier. In a plot $ln(J/T^2)$ vs $E^{1/2}$ we observed a linear dependence equivalent to a barrier height of Φ_b=1.73±0.0032eV at an electric field of 1.2- 4.2 V/µm and 472-672K temperature.

Further results including additional diamond samples and alternative contact metals will be presented.

References:

[1] M. Schreck *et al.*, J. Appl. Phys. **92** (2002) 676
[2] M. Schreck *et al.*, Appl. Phys.Lett. **84** (2004) 4541
[3] E. Berdermann *et al,* Diam. Relat. Mater. (2009), doi:10.1016/j.diamond.2009.11.019
[4] M. Promoski, *PhD thesis,* Univ. of Frankfurt 2008
[5] A. Stolz *et al.,* Diam. Relat. Mater. **15** (2006) 807

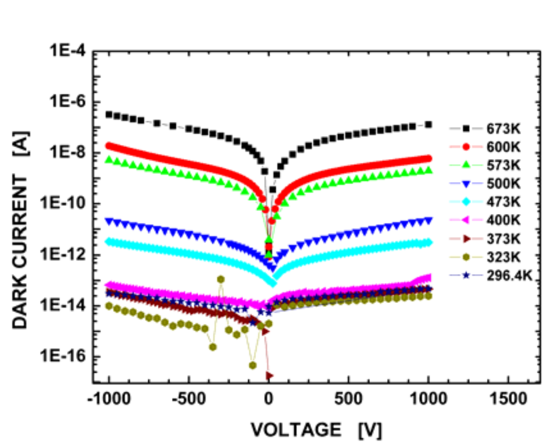

Fig.1 Dark current as function of bias voltage.

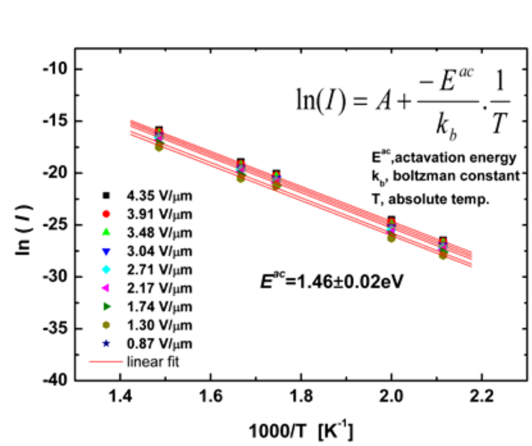

Fig.2 Arrhenius plot of dark current of a diamond-on-iridium (DoI) sample.