Single Crystal CVD Diamond for Detector Applications

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There are several major scientific infrastructure projects currently under development around the world that will use radiation of various kinds at much high intensity than the current generation of experiments. Whilst it is possible to construct the more intense radiation sources, the detectors are less developed. One detector material that could potentially meet the demands of new generations of high intensity sources is single crystal CVD diamond (SC-CVDD), believed to be the most radiation damage resistant solid because of its high density of very strong bonds joining low atomic number atoms.

In recent years Element Six have made significant advances in the development of SC-CVDD. It has been demonstrated that SC-CVDD can have outstanding electronic properties, with carrier mobilities significantly exceeding those measured in natural diamond and carrier lifetimes exceeding 100 ns [1]. When SC-CVDD is used as a detector for minimum ionising particles, such as high-energy electrons, it shows approximately 100% charge collection efficiency, with very high uniformity over areas of several mm^2. The wide band gap means that dark currents are very low, often a few pA, giving detectors with a high signal to noise ratio.

We will review the current state-of-the-art in SC-CVDD for detectors, including the doping to make controlled absorption devices for beam position monitoring, and highlight some of the areas in support technology, such as radiation-hard contacts, where further understanding is required for more widespread implementation of diamond detectors.

References

[1] – J. Isberg et al, Science **297**, 1670-1672 (2002)