Diamond-Based Tracking Detectors For High Energy Physics

Lucas Ong[a] , Kumaravelu Ganesan[a], Andrew Alves[a], Elisabetta Barberio[a], Geoffrey Taylor[a], Steven Prawer[a]

[a]*The School of Physics, The University of Melbourne, VIC 301.*

I. INTRODUCTION

Silicon is the preferred material for sensors used in high precision charged particle tracking detectors, even in the harsh radiation environment posed by the Large Hadron Collider (LHC). However, the upgrade in luminosity planned for the LHC after the first years of operation will demand even higher radiation resistance of the critical pixel detectors that must be situated close to the high-energy interaction point.

The Super LHC (SLHC) aims to deliver luminosity larger by an order of magnitude to the LHC and with it the projected radiation levels will rise considerably. As a consequence new types of sensors for pixel detectors need to be developed which are capable of coping with the expected radiation fluence of up to 10^{16} particles/cm2. Diamond provides a suitable candidate for the next generation of tracking detectors [1][2][3].

Unlike traditional Si detectors, diamonds posses a large band gap, high thermal conductivity and resistance to radiation damage. This results in a device capable of room temperature operation. For experiments such as ATLAS (**A** **T**oroidal **L**HC **A**pparatu**S)** this represents a significant reduction in the complexity of cooling infrastructure and power consumption.

II. RESEARCH UNDERTAKEN

A R&D effort is currently underway to design and investigate the performance of synthetic diamond in tracking devices.

We investigate the patterning of samples and the metallization of single crystal Chemical Vapor Deposition (scCVD) and polycrystalline Chemical Vapor Deposition (pCDV) diamond. We perform Ion Beam Induced Charge (IBIC) scans to characterize the uniformity and efficiency of charge collection across single crystal devices. We electrically characterize the samples and study the performance of thin crystals. In addition, pCVD samples have been combined with existing read out electronics and studied with a pion beam at (CERN, Switzerland).

III. SUMMARY

Studies into performance of next generation diamond detectors are on going and suggest a viable alternative to silicon tracking devices for high-energy particle physics
Experiments.

With further refinement it is expected that diamond detectors will reach performances suitable for precision tracking applications with radiation hardness substantially higher than that of current Silicon devices.

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