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Simulation and characterisation of a low gain avalanche detector for particle physics and synchrotron applications

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Low Gain Avalanche detectors (LGAD) are part of family of Avalanche Photodiodes but have only small gain of an order of magnitude. LGAD's have been shown to have a very fast response time, order of picoseconds, which can make them useful in many applications, including concurrent excellent time and position resolution tracking for particle physics and synchrotron applications. Coupling of LGAD devices with single photon counting pixel detectors will allow detection of incident X-rays of energy below the noise threshold of the electronics, making them of interest to the Synchrotron community.

In this work we present results of TCAD detector simulations, fabrication and characterisation. Synopsis TCAD software was employed to perform fabrication process simulations, electrical properties modelling, detector response to incident radiation and influence of doping on gain variations. Several devices with optimised parameters and nominal no-gain sensors were fabricated at Micron Semiconductor Ltd. These were characterised using Transient Current Technique(TCT) and alpha particle TCT for charge collection, gain variation and sensitivity.

The results presented here concentrate on those obtained from devices fabricated in Run 2. Where Run 1 saw a small amount of gain. The simulation has been modified to match these results and new simulations performed to optimize the devices. Under test these devices have shown to match within error to the simulated results for both IV and gain measurements. Preliminary results show a gain factor of 3-6 is obtained for voltages in the range of 200-800V.

Further device optimization in simulation is presented, which produces higher gain and allows operation with higher bias voltages.

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