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Towards Active Edge Silicon Sensors Fabricated with Edge Ion Implantation And Microwave Anneal Activation

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Silicon detectors typically require a large inactive region surrounding the sensitive region, to accommodate guard rings, which help maintain the electric field uniformity around peripheral pixels, and isolate high current generation due to defects at the physical edges of the detectors. Sensors with reduced inactive regions around their periphery are desirable for applications in high-energy physics, X-ray experiments, and medical imaging. A solution to reduce or eliminate this inactive area is the use of active-edge technology. However, implementing active edges has presented significant challenges in sensor fabrication. Typically, a support wafer is necessary, as a trench is etched fully through the device substrate and subsequently must be filled with polysilicon for re-planarization, in order to enable the subsequent fabrication steps. The process would be greatly simplified if the edges could be doped after all other fabrication steps. This is generally not feasible with conventional methods due to the high-temperature annealing required after doping the guard rings or active-edge structures. Microwave annealing offers a promising alternative to traditional high-temperature annealing, since dopants are activated while the bulk temperature remains below 500 ℃ , enabling activation after all other fabrication steps are complete. This study explores a new method of achieving active-edge detectors, in which the device edges are implanted after dicing and subsequently microwave annealed. As a feasibility test, several readily available devices underwent edge ion implantation and microwave annealing. The tested devices include both p-in-n and n-in-p devices. Results from TCAD simulations exploring the effects of fixed oxide charge and large surface recombination velocity on both device polarities will be shown. These demonstrate the expected qualitative features of I-V measurement performed before and after the edge implantation and annealing. Results of these measurements will be shown, demonstrating a reduction in leakage current after the edge is doped, indicating the successful buffering of the edge current generation by the activated dopant.

Type of presentation (in-person/online)

online presentation (zoom)

Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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