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Annealing effects on operation of thin Low Gain Avalanche Detectors

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Several thin Low Gain Avalanche Detectors from Hamamatsu Photonics were irradiated with neutrons to different equivalent fluences up to $\Phi_{eq} = 3 \cdot 10^{15} \text{ cm}^{-2}$. After the irradiation they were annealed at 60°C in steps to times > 20000 minutes. Their properties, mainly full depletion voltage, gain layer depletion voltage, generation and leakage current, as well as their performance in terms of collected charge and time resolution, were determined between the steps.

It was found that the effect of annealing on timing resolution and collected charge is not very large and mainly occurs within the first few tens of minutes. It is a consequence of active initial acceptor concentration decrease in the gain layer with time, where changes of around 10% were observed. For any relevant annealing times for detector operation the changes of effective doping concentration in the bulk negligibly influences the performance of the device, due to their small thickness and required high bias voltage operation. At very long annealing times the increase of the effective doping concentration in the bulk leads to a significant increase of the electric field in the gain layer and, by that, to the increase of gain at given voltage. The leakage current decreases in accordance with generation current annealing.

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