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Evaluation of the limited response property in Silicon Photomultiplier with different micro cell size

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The SiPM(silicon photomultiplier) consists of several thousand of micro cells which are operated in geiger mode. In this Geiger mode, only one micro cell is fired when several photons are incident on the same micro cell at the same time. Therefore the dynamic range of the SiPM is determined by the total number of micro cells. The output pulse is shown a linear response when small amount of photons are incident on the detector. However the pulse height became saturated as increasing the amount of the light intensity because of the overlapping of incident photons into same micro cell. This non-linearity response is a severe problem when the number of photoelectrons exceeds the total number of micro cells. A commonly used simple exponential model for the evaluation of the number of fired micro cells from the amount of generated photoelectron is described by poisson distribution. The number of photoelectron is a generated photoelectron from incident photons which contribute to the triggering signal that can be calculated by multiplying the number of incident photons and PDE(photo detection efficiency) of the SiPM.

In this study different size of the micro cells are considered with different intensity of incident photons. The energy resolution of the SiPM with considerations of the non linear response was calculated [1] and the statistic photon loss can be considered from the simple exponential model. The SiPM test sample is fabricated with <100> oriented 6 um thick epitaxial wafers having 12 Ω -cm at National Nano Fab Center (NNFC) in Korea. The SiPM is designed with 2 mm of width including 4 different sizes of the microcell; 15, 20, 30, 50 um respectively. Incident photons which have a pulse width less than a recovery time of the SiPM are tested to prevent additional triggering of the micro cell after recharging of the micro cell using a picoseconds laser pulse diode with several wavelengths.

Reference

[1] A. Stoykov et al "On the limited amplitude resolution of multipixel Geiger-mode APDs, "J. instrum., vol. 2, p. P06005, Jun. 2007

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