Motivation

- Collected charge in silicon detectors decreases with particle fluence. (see Fig.1)
- This effect is more pronounced in n-type bulk detectors than in p-type.
- The p-type material is under investigation for High-Luminosity LHC.

Having a thin sensor with built-in amplification allows to reduce the thickness without significant signal loss. In addition trapping probability is proportional to the thickness. Diodes with low built-in amplification have been produced by CNM- Barcelona, within the RD50 collaboration.

What is the Transient Current Technique?

Transient Current Technique is an experimental method where charge carriers are injected from the top or bottom surface of the sensor. We use red laser TCT. The drift of these charges is studied, obtaining information on the electric field inside the diode out of the transient induced current.

First results with TCT measurements

Analysis method of the gain

At 800V a kink can be seen at about 15ns (t1). This kink marks the end of the electron drift and the beginning of the holes drift (see Fig.2). The gain was calculated as follows.

\[ Q_e(t) = \int_{t_0}^{t_1} I(t) dt \]  
\[ Q_h(t) = \int_{t_1}^{t_2} I(t) dt \]

\[ Gain(800V) = \frac{Q_h(800V)}{Q_e(800V)} \]

For bias within [120,780] V the gain is defined as

\[ Gain(V) = \frac{Q_{total}(V)}{Q_{total}(800V)} \times Gain(800V) \]

Fig.4 Induced transient current for back illumination at different bias voltages.

With increase of bias voltage:
- minimum value of current increases in absolute value
- drift time reduces

Fig.5 Gain before irradiation. The gain increases with bias voltage and reaches 2.4.

Summary

- I am testing a candidate of thin p-bulk detectors for experiments at the High Luminosity LHC.
- I have measured several non-irradiated diodes with built-in amplification. These devices were manufactured by CNM-Barcelona within the RD50 collaboration. Multiplication starts at Vbias>100 V and reaches a maximum of 2.4 at 800 V.

Next step

- Irradiate these detectors and study degradation of gain with particle fluence.

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