Paper submitted for presentation at the
Sixth International "Hiroshima" Symposium on the
Development and Application of Semiconductor Tracking
Detectors (**STD6**)
Carmel Mission Inn, California, September 11-15, 2006

Oral Contribution.
Corresponding/presenting author:
Dr. Claudio Piemonte
tel. +39 0461314428
email: piemonte@itc.it

"Status of the development of 3D silicon detectors at ITC-irst"

C. Piemonte[1], M. Boscardin[1], L. Bosisio[2], G.-F. Dalla Betta[3], A. Pozza[1], S. Ronchin[1], A. Zoboli[2], N. Zorzi[1]

[1] ITC-IRST, Divisione Microsistemi, 38050 Povo - Trento, Italy
[2] INFN Trento and Università di Trento, 38050 Povo - Trento, Italy
[3] INFN Trieste and Università di Trieste, 34127 Trieste, Italy

In the mid nineties a new architecture of silicon radiation detectors, called 3D detector, has been proposed, which involves the fabrication of the electrodes deep inside the silicon wafer. This detector concept has soon given rise to a great interest because of its intrinsic advantages over standard planar detectors. Indeed, due to the fact that the electrode distance depends on the layout, rather than on the wafer thickness, it is possible to shorten the electrode distance allowing for low depletion voltage and fast charge collection times. Notably, this is obtained without reducing the amount of signal charge released by a particle. In heavily irradiated planar detectors the increase of the depletion voltage and the reduction of the charge carrier mean drift length due to trapping effects are a major issue. In 3D detectors, a direct consequence of the low depletion voltage and short distance between electrodes is an increase of the radiation tolerance.
A drawback of 3D detectors is the rather long and complex fabrication process, as methods of silicon micromachining must be used.

In our previous works we described a new architecture of 3D detector, called 3D-single type column (3D-stc), whose main purpose is the simplification of the fabrication process. This device consists of columnar electrodes of one doping type only, e.g., n+ columns on a p-type substrate, which is the case of our first production batch. Owing to the single column etching and doping step, the fabrication process of these devices is much simpler. Moreover, if columns are only partially etched through the wafer thickness, an additional simplification is related to the fact that no support wafer during processing is necessary and the ohmic electrode can be obtained by means of a uniform implant/diffusion on the back side of the wafer.

In this contribution we report experimental results from the electrical characterization of three batches of 3Dstc detectors manufactured in the period from the beginning of 2005 to mid 2006. The reproducibility of the experimental data and the good performance in terms of leakage current demonstrate the reliability of the fabrication process developed at ITC-irst, Trento (Italy).
Some samples have recently been irradiated with neutrons and selected results from the electrical characterization of these devices will be shown.
Finally, we will briefly describe the main characteristics of the new batch of double-column 3D detectors that will be produced starting from next summer.