INTRODUCTION

Detectors made of High Purity Germanium crystals are the most important instruments for high resolution gamma spectroscopy.

The aim of this research activity is to obtain a chemically and electrically stable passivation of the Ge surface, capable of sustaining high voltages and ensuring very low leakage currents [1], also taking into account that Ge native oxides are water-soluble and decompose by heating and then are not stable.

MEASUREMENTS

To determine the properties of the passivation applied to an HPGe detector, a new set-up was developed [2]. With this set-up we have scanned the passivated surface with a collimated $^{241}$Am gamma source and a micrometric linear motion device.

The crystal has been mounted always in the same way and the collimated source has been moved along the same part of the crystal. The bias voltage was set at 1500 V for each passivation.

As shown in ref. [3], hydride termination could be an ideal surface passivation where each hydrogen atom is bonding to a single Ge surface dangling bond. For this reason we have studied the hydride terminations obtained with different acid concentrations of surface preparations, that we have called: Low H (acid concentration around 10%), High H (acid concentration around 30%) and Hyper H (acid concentration around 30% but with a “more aggressive” surface preparation that we cannot discuss here).

The analysis of the photo-peak spectra for the $^{241}$Am line is necessary in order to evidence the charge collection dynamics close to the surface and allows seeing the profile of inactive zones induced by passivation.

RESULTS AND DISCUSSION

Figure 1 shows the scans performed for H-terminated passivation at different concentrations. The experimental data have been acquired starting at 2.5 mm from the contacts, considering the thickness of contact dead layers and the spot diameter. The trends of the counting rates are different for the three passivations. The counting rate of low H passivation decreases from the $n^-$ to $p^+$ contact ($n$-type surface), while the counting rate in high H passivation increases from $n^-$ to $p^+$ contact ($p$-type surface).

This behavior is produced by a different surface recombination of the carriers, electrons for low H passivation and holes for high H passivation. According to ref. [3] the hydride-termination shows that it has the capability for ideal passivation, because for the hyper H the counting rate remains constant along all the scan.

Fig. 1. Photo-peak counting rates (59.54 keV line) of the H-passivated detector, measured during the lateral scans for the different passivations.

CONCLUSIONS

Differences in photo-peak counting rate could be explained with the hypothesis of weak or distorted field regions, where full electric charge collection is not achieved, because they recombine or are driven elsewhere.

The lateral scan measurements allowed highlighting the electrical nature of the passivated surfaces: low H passivation gives rise to an n-type surface, the high H termination gives a p-type surface and hyper H gives an ideal one.

To better understand the observed phenomena additional measurements with digital electronics and pulse shape analysis have been started.