Experimental Report

Proposal: **3-01-605** **Council:** 4/2012

Title: Characterization of integrated deltaE/E detector telescope with light charged particles and fission fragments

This proposal is a new proposal

Researh Area: Methods and instrumentation

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Samples: 235UO2

Instrument	Req. Days	All. Days	From	To
PN1	3	3	22/11/2012	25/11/2012

Abstract:

Our lab is producing integrated deltaE–E detector using a custom developed fabrication process which is adapted from bipolar silicon integrated circuit technology. The deltaE detector is fabricated on the top side of the wafer by depositing an epitaxial layer and the E detector is realized on the back side of the substrate wafer.
We would like to characterize three deltaE-E detector telescopes with deltaE thickness in the range of 10µm-25 µm each with mass- and energy-selected fission fragments and light charged particles (alpha, Li, Be, C, O) provided by the LOHENGRIN spectrometer.

ILL Experiment Report

Introduction

Our group is involved in developing several types of silicon detectors for particle physics and nuclear physics experiments using the fabrication facilities in India. A novel type of ΔE–E integrated silicon detector telescope is presently being developed for the identification of charge particle and energy measurement in nuclear physics experiments. To overcome the problems (fragile, difficult to handle and quite expensive due to production methods of silicon etching) in conventional Delta E-E detector telescopes, in this development the ΔE and E detectors are integrated back to back on the same silicon wafer by using a custom developed fabrication process, adapted from bipolar silicon integrated circuit technology. Initial characterization of these detectors was carried out at FOTIA and Pelletron BARC using a 12 MeV $^{7}Li^{+}$ beam on a ^{12}C target. The experiments were successful in terms of clear identification of discrete alpha group.

Experiment

To test the performance of the integrated ΔE–E detector telescope for identification of heavier ions with higher Z with varying energy, experiments were carried out using the **Lohengrin** mass spectrometer at ILL France. Lohengrin provides the facility to selected mass number, charge state as well as energy of the particles produced as fission fragments. Measurements were mostly carried out for fission fragments of mass numbers from 80 to 145 and kinetic energies from 35 MeV to 130 MeV. Many light particles such as alpha, carbon, oxygen produced in ternary fission or as stable element recoils were also used for characterization. The test run included several combinations of mass number, charge state of fission fragment and their energy for complete characterization. The detector was also characterized for resolution of the E detector by implanting the beam from the back side and for the delta E detector by placing the telescope at an optimized angle so that the incident particle loses its whole energy in the delta E detector. The incident beam used for this

purpose were alpha particles of energy 4.7 MeV and the optimization of the angle was done by tilting the detector with respect to the incident beam.

Results

The 2D spectra showed that our ΔE-E detectors can clearly identify and separate fission fragments. The energy calculated using the derived coefficients shows good agreement with the experimental energies of the fission fragments. The mass resolution ΔM is almost constant at ~1.35 amu. The energy resolution of the ΔE detector is found to be 1.33% and the E detector 0.52% for 11 MeV α – particles.

The experiment at ILL demonstrated the features of particles present in the final channel indicating the success of the experiments and applicability of these telescopes for particle identification. The results of the performance tests will also allow us to optimize the process parameters for fabrication of the detector so as to get the best performance for future fission studies and fission product spectroscopy. These studies are to be presented in “International Symposium on Nuclear Physics”, INDIA.