Thickness estimation of thin silicon strip detector

Aryan Goyle[1],* S. K. Pandit[2,3], V. V. Parkar[2,3], Satbir Kaur[2,3], Prabhat Mishra[2,3], K. Mahata[2,3], A. Shrivastava[2,3], and P. Patale[2]
[1] *UM-DAE Centre for Excellence in Basic Sciences, Mumbai - 400098, India*
[2] *Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai - 400085, India and*
[3] *Homi Bhabha National Institute, Annushakti Nagar, Mumbai - 400094, India*

Introduction

The use of double-sided silicon strip detectors (DSSSDs) for the detection of charged particles is becoming increasingly popular in experiments of low and high energy nuclear physics [1].The DSSSDs, provided by Micron Semiconductors [2], are used in our experiments for inclusive and exclusive breakup studies [3]. These detectors have 16 horizontal strips (n-side) and 16 vertical strips (p-side), making 256 pixels. Signals from both sides are read out through Mesytec electronics [4] and recorded through the CAEN VME based data acquisition system. Knowledge of the thickness of the strip detector, used as ΔE in the telescope configuration, is imperative to achieve better energy and mass/charge resolution [5, 6]. In the present work, we have estimated the thickness profile of thin DSSSDs from energy loss technique.

Analysis Method

A typical two-dimensional α energy spectrum, measured using DSSSD in telescopic (ΔE − E) configuration, is shown in Fig. 1(a).Both ΔE and E detectors were calibrated using the known energies of α-particles from ^{239}Pu-^{241}Am and ^{229}Th sources. The energy loss technique is employed to measure the thickness of ΔE-detectors in each pixel. Two groups of α-particles of energy 15.0±0.1 MeV and 10.0±0.1 MeV were considered.

The projection of the spectrum on the ΔE axis corresponding to E_α = 10.0±0.1 MeV is shown in Fig.1(b). The projected energy loss spectra are fitted with a Gaussian shape,

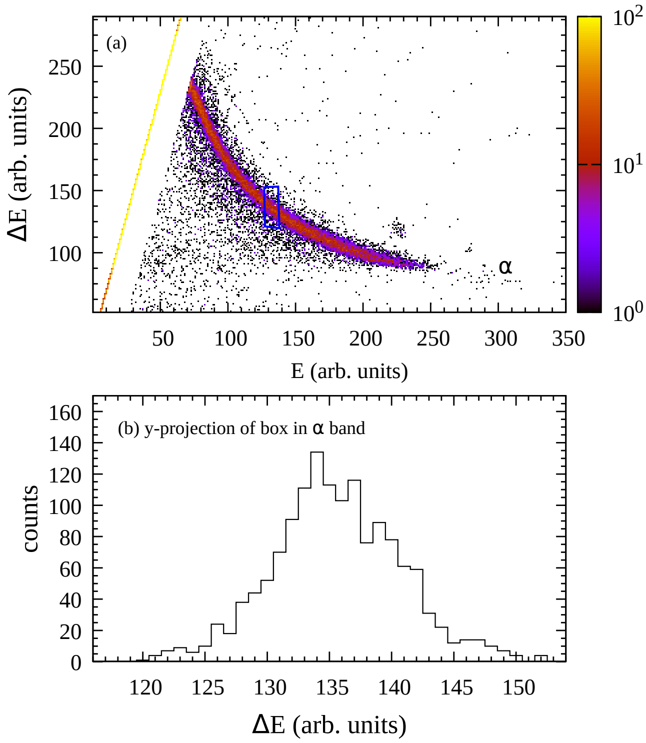

FIG. 1: (a)ΔE vs E plot showing the α particle band. The box given in the region taken for determination of energy loss for the particular energy of the α particle. (b) Y-projection of the box shown in the α band.

to estimate the mean energy loss and uncertainty (width of the Gaussian shape).SRIM code is used for the estimation of energy loss of the α-particles in Si-detector.The range of the α-particles inside the detector material is decided by its dE/dx behavior.The E versus range characteristic is exploited to estimate the energy loss in the ΔE-detector.The same

*Electronic address: aryan.goyle@cbs.ac.in

TABLE I: The measured thickness of the 8x8 quadrant from 10 and 15 MeV α-particles.

E_α (MeV)	Thickness (μm)	Average Thickness (μm)
10.0 $\pm$ 0.1	29.27 $\pm$ 1.44	
		29.98 $\pm$ 1.9
15.0 $\pm$ 0.1	30.68 $\pm$ 1.24	

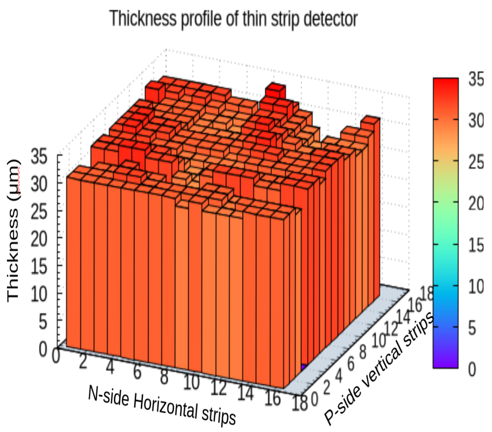

FIG. 2: The thickness profile of 30 μm DSSSD detector.

method was repeated for $E_\alpha = 15\pm$ 0.1 MeV and it was found to match the extracted values at $E_\alpha = 10\pm0.1$ MeV.The extracted thickness for the pixel corresponding to the 8x8 quadrant is tabulated in Table I. The average value of the thicknesses measured at $E_\alpha = 10.0\pm0.1$ MeV and 15.0$\pm$0.1 MeV is also given.

Summary

The thickness profile of thin silicon strip detector was obtained employing energy loss of α particle. It is found that the measured average thickness is close to the value given by the manufacturer. The thickness profile will be useful for getting a better energy and mass/charge resolution.

Acknowledgements

One of the author (Aryan Goyle) would like to thank DST-India for providing the INSPIRE scholarship.

References

[1] U.C. Bergmann *et al.*, Nucl. Instr. Meth. Phys. Res. A **515**, 657 (2003).
[2] https://www.micronsemiconductor.co.uk
[3] S. K. Pandit *et al.*, Phys. Rev. C **93**, 061602(R) (2016), *ibid* Phys. Rev. C **100**, 014618 (2019).
[4] https://www.mesytec.com/
[5] M. Uroić *et al.*, Eur. Phys. J. A **51**, 93 (2015).
[6] S. K. Pandit *et al.*, J. Instrum. **14**, T01005 (2019).