Transfer induced fission fragment angular distribution in $^{11}B+^{238}U$ reaction at near barrier energy

T. N. Nag[1], R. Tripathi[1]*, S. Sodaye[1], K. Sudarshan[1], A. Pal, S. Santra[2], K. Ramachandran[2], D. Chattopadhyay[2], A. Kundu[2] and P. K. Pujari[1]

[1]*Radiochemistry Division, Bhabha Atomic Research Centre, Mumbai - 400085, INDIA*

[2]*Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai - 400085, INDIA*

* *email: rahult@barc.gov.in*

Introduction

Fission fragment angular distribution (FFAD) is an important observable to investigate the contribution from different mechanisms of fission processes involved in the heavy ion induced nuclear fission. For compound nucleus fission FFAD can be explained by statistical model calculation [1,2], where as non compound nucleus fission shows anomalous fission fragment angular distribution. In the case of heavy ion induced fission of actinides, along with full momentum transfer of the projectile to the target (capture of complete projectile), there is a chance of transfer of a few nucleons or nucleon clusters to the target. These transfer processes become more important when the reactions are carried out near the entrance channel coulomb barrier. However, it is quite difficult to delineate the fission fragment angular distribution for transfer channels involved in a particular reaction due to the large contribution from full momentum transfer events. There are very limited numbers of studies to exclusively find out the fission fragment angular distribution for such transfer processes particularly close to the entrance channel coulomb barrier [3,4].

In order to investigate the fission fragment angular distribution for different transfer channels, inclusive as well as exclusive measurements of fission fragment angular distribution was carried out in $^{11}B+^{238}U$ at E_{lab}=60 MeV (E_{cm}/V_c=1.05)

Experimental details

Experiments were carried out at BARC-TIFR Pelletron-LINAC accelerator facility, Mumbai with 60 MeV ^{11}B beam. An electrodeposited ^{nat}U target on an aluminum backing was used for the experiment. Online measurement of the fission fragments and projectile like fragments (PLFs) were carried out using four E-ΔE telescopes of silicon surface barrier strip detectors. Among these four set of telescopes, two of them were exclusively used for the detection of fission fragments, whereas PLFs were detected in all the telescopes. Each strip detector was having sixteen strips. Two monitor detectors were placed $\pm 20^0$ with respect to the beam direction to normalize for the beam current and target thickness. Online measurement was carried out in covering angle range around 90^0 to 170^0.

Results and discussions

A typical 2D spectrum of different PLFs is shown in Fig. 1. PLFs angular distributions showed that the major transfer channels are alpha transfer, proton transfer and proton pick up, among which proton transfer is the most dominant transfer channel. Angular distribution of ^7Li is shown in Fig. 2 which is peaking close to the grazing angle.

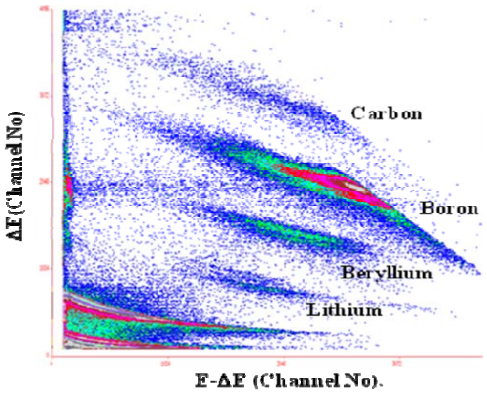

Figure1: A typical 2D spectrum of PLFs.

Fission products are completely stopped in thin ΔE detector and these counts from fission strip detectors were taken to get the laboratory

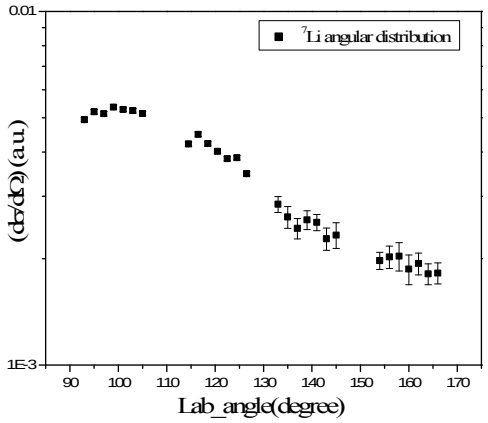

Figure 2: ^{7}Li angular distribution in $^{11}B+^{238}U$ reaction.

angular distributions of fission fragments which were then transformed into centre of mass (CM) frame of reference assuming full momentum transfer and using standard kinematic equations with kinetic energies calculated using the prescription of ref [5]. Inclusive fission fragment angular distribution is shown in Fig. 3. The angular anisotropy value for inclusive measurement was observed to be close to the value reported in literature [6].

In order to find out the angular distribution of the fission products obtained due to transfer induced fission (TF), fission fragment angular distributions were generated in co-incidence with PLFs corresponding to different transfer channels. A preliminary analysis shows that the angular anisotropy values for the transfer channel are higher compared to that for inclusive fission fragment angular distribution.

Conclusions

Online measurement of inclusive and PLF gated fission fragment angular distribution was carried out in $^{11}B+^{238}U$ reaction. PLF angular distribution showed proton and alpha transfer to be the dominant channels. Angular anisotropy for inclusive fission fragment angular distribution was observed to be close to the literature value. A preliminary analysis of exclusive fission fragment angular distribution gated with outgoing PLF shows higher anisotropy values in comparison to that for inclusive fission fragment angular distribution.

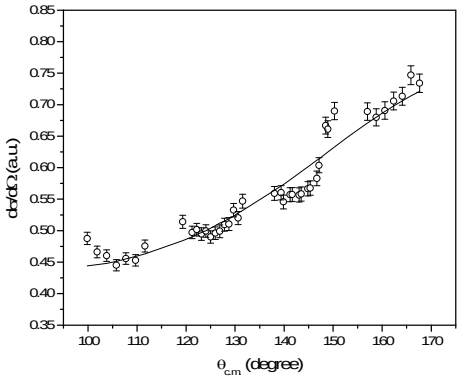

Figure 3: Inclusive fission fragment angular Distribution.

References

[1] R. Vandenbosch and J. R. Huizenga, *Nuclear Fission* (Academic Press, London, 1973).

[2] I. Halpern and V. M. Strutinsky, in *Proceedings of the Second United Nations International Conference on Peaceful Uses of Atomic Energy, Geneva, 1958*, edited by J. H. Martens *et al.* (United Nations, Switzerland, 1958), Vol. 15, p. 408.

[3] A. Saxena *et al*., Phys. Rev. C **65**, 064601 (2002).

[4] F. Videbaek *et al*., Phys. Rev. C **35**, 2333 (1987).

[5] H. H. Rossner *et al*., Phys. Rev. Lett. **53**, 38 (1984).

[6] A. Karnik *et al*., Phys. Rev. C. **52**, 3189 (1995).