MEASUREMENT OF STOPPING POWER OF ALPHA PARTICLES IN LIGHT MATTER

Le Xuan Chung, Ha Thi Mai Hoa, Pham Quoc Hung
Duong Thanh Tung, Doan Quang Tuyen

Department of Physics, College of Science, VNU

1. Introduction

Stopping power data have many applications in nuclear physics, matter analysis sciences, radiology and radiation safety and other studies. Stopping power data at lower energies are interesting because of the low energy values mostly come from extrapolation of analytical fits of the higher energy data. Therefore, experimental determinations of stopping power at lower energies are necessary.

2. Measurements and results

In this paper, the transmission of several MeV energies alpha particles in lapxan was studied. Analyzing the measured transmission spectra stopping power of lapxan was determined. Used alpha source is IAEA standard. It includes four α-decay nuclei: ^{238}U, ^{234}U, ^{239}Pu and ^{241}Am. It was prepared by electron deposition of a mixture of α– emitters onto a stainless steel disk. Standard source's calibration date was in June 10, 2002 10:00, total activity was 374.4 dpm and its diameter of active area was 24.4 mm. The detail information of standard source are given in table 1.

Table 1. Information of standard source

Isotope	Activity (dpm)	Half-Life	Expanded uncertainty (dpm)	Energy range (keV)
U - 238	92.0	4.468 E9 y	3.2	3900 – 4290
U - 234	89.9	2.455 E5 y	3.1	4560 – 4880
Pu - 239	93.3	2.41 E4 y	3.2	4900 – 5240
Am - 241	94.2	4.322 E2 y	3.3	5260 – 5620

Measurements were performed using Alpha Analyst Spectrometer [1] at Department of Nuclear Physic, Hanoi University of Sciences.

Measured spectra are presented in fig. 1 a, b, c.

a) The transmission of alpha particles in matter

Fig. 1 shows that some alpha particles of 5.1 and 5.4 MeV can go through lapxan of 10 μm and 20 μm thickness without losing energy. Using measured results, the transmission in lapxan of 5.1 and 5.4 MeV alpha particles are calculated and presented in table 2.

Table 2. Transmission of 5.1 and 5.4 MeV alpha particle in lapxan without losing energy

Energy (MeV)	(%) after 10 μm lapxan	(%) after 20 μm lapxan
5.109 ± 0.051	0.654 ± 0.013	0.514 ± 0.013
5.412 ± 0.054	0.985 ± 0.022	0.875 ± 0.016

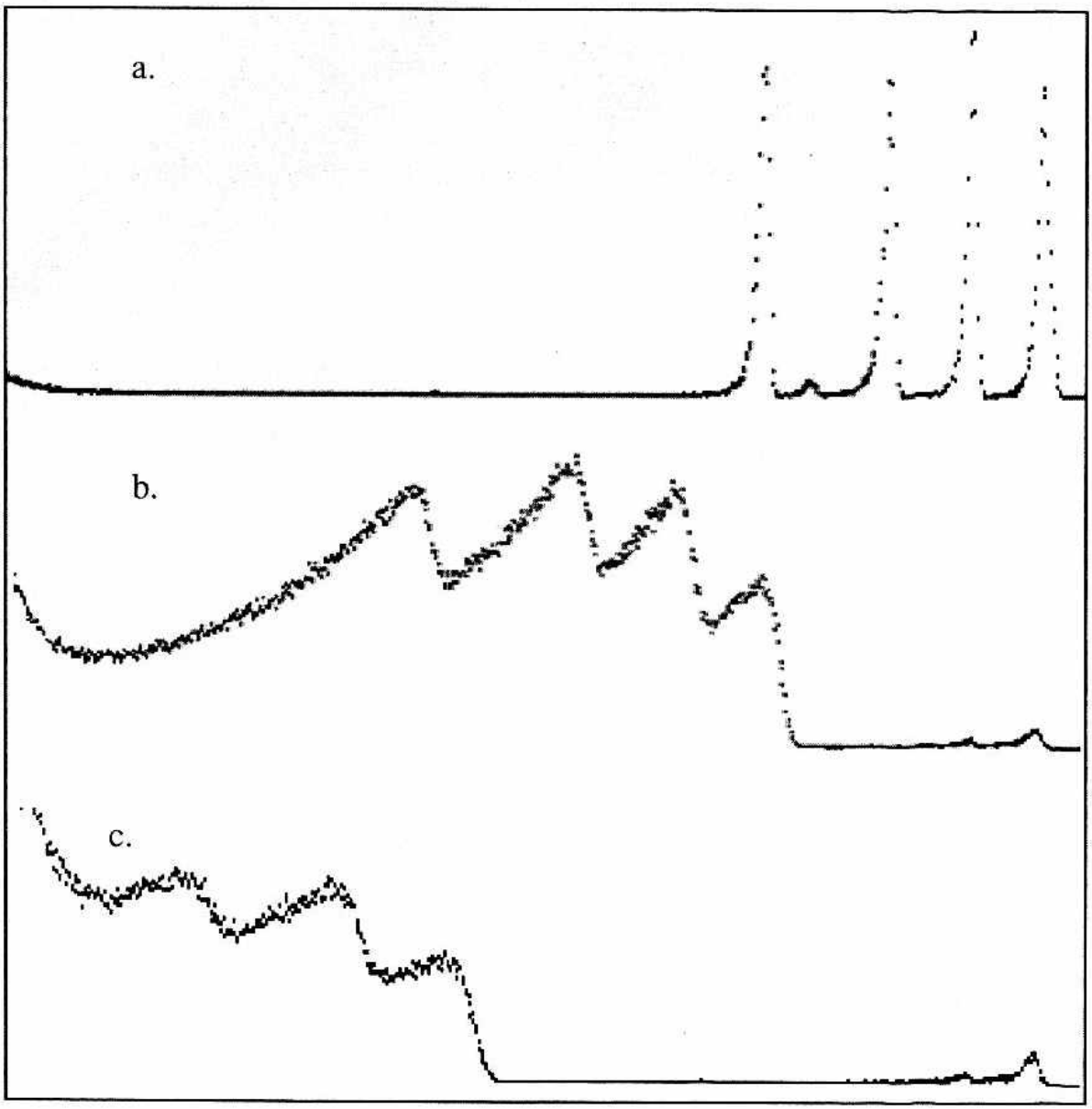

Fig.1. Alpha spectrum

a. Alpha spectrum in vacuum
b. Alpha spectrum after 10 μm of lapxan
c. Alpha spectrum after 20 μm of lapxan

b) Stopping power of lapxan

We have measured the stopping power of lapxan for alpha particles of energy region from 4.2 to 5.4 MeV. We have used the transmission technique. The thickness of a lapxan foil is of 10 μm. The difference between the channels of the single peak centered is equal to loosed energy of the particle in lapxan. Measurements were performed by Alpha Analyst Spectrometer. Energy calibration of the surface barrier silicon detector was done by the measurement for IAEA standard source in vacuum.

Using the result presented in the Fig.1, we calculated dE/dx of lapxan for 4.22, 4.75, 5.11 and 5.41 Mev alpha particles. The results are presented in table 2.

Table 2. Stopping power of lapxan

Peak	E (MeV) vacuum	E (MeV) 10 μm	E (MeV) 20 μm	dE_{01}/dx (10^3.MeV/cm)	dE_{12}/dx (10^3.MeV/cm)	dE_{02}/dx (10^3.MeV/cm)
1	5.412±0.054	4.152±0.042	2.642±0.026	1.260±0.026	1.510±0.030	1.390±0.028
2	5.109±0.051	3.725±0.037	2.064±0.021	1.380±0.028	1.660±0.034	1.520±0.030
3	4.751±0.048	3.157±0.032	1.408±0.014	1.590±0.032	1.750±0.036	1.670±0.034
4	4.223±0.042	2.458±0.025		1.770±0.036		

dE_{ij} = E (i foils) – E (j foils)

3. Conclusion

The experimental data results received in this study show some main characteristics of the transmission of Alpha particles of several MeV energy in Lapxan light matter:

Transmission probability of alpha particle through lapxan matter increases when alpha particle energy increases.

The stopping power of matter decreases when alpha energy particle increases. That is an agreement with the theory.

With accuracy of 1 - 2%, stopping power of lapxan for given energy of alpha particle are independent on the lapxan foil's thickness. The stopping power values received in this study agree with the others [2].

Acknowledgements: The authors thank VAEC for instrumentation support. This study has been completed with financial support of the Vietnam National Program in Natural Science.

References

1. CANBERRA, *Model S570 Genie - 2000 Alpha Analyst User's Manual*, ISO 9001 System Certified.
2. M. Azzouz et al., *UCL – I. I. S. N R.* 2000.