III DATA EVALUATION

Evaluation of Activation Cross Sections for (n,α) and (n,n'α) Reactions on $^{63,65,Nat}Cu$

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Introduction

Copper is a very important structure material in nuclear fusion engineering. The neutron activation cross section are very useful in fusion research and other applications such as radiation safety, environmental, material damage and neutron dosimetry. More efforts are required to identify and resolve the differences and discrepancies in the existing activation cross sections from different laboratories.

The natural copper consists of two stable isotopes, i.e. ^{63}Cu, ^{65}Cu. Their abundaces and threshold energies are given in Table 1.

Table 1 Isotopic abundaces and their reaction threshold energies of copper

isotope	(n,α) thresh. / MeV	(n,n'α) thresh. / MeV	abun. / %
^{63}Cu	1.715(Q-Value)	5.869	69.17
^{65}Cu	0.08423	6.876	30.83

The cross sections of (n,α) and (n,n'α) for $^{63,65,Nat}Cu$ are recommended based on the available experimental measured data and theoretically calculated results[1] from threshold up to 20 MeV. The evaluated cross sections are given in Figs. 1 ~ 6 with experimental data and compared with other evaluated data. The present work was done for CENDL-3.

1 $^{63}Cu(n,\alpha)^{60}Co$ Reaction

The experimental data were measured by Majdeddin(97), Lu Halin(91), Meadows(91), Csikai(91), Ikeda(91), Wang Yongchang(90), Greenwood(85), Winkler(80), Garuska(80), Artem(80), Paulsen(67), and Cserpak(94)[2~13] in the energy range from threshold up to 20.0 MeV, respectively. The evaluated data were

obtained by fitting experimental data from threshold energy to 20.0 MeV. The comparison of experimental data with evaluated ones is shown in Fig.1.

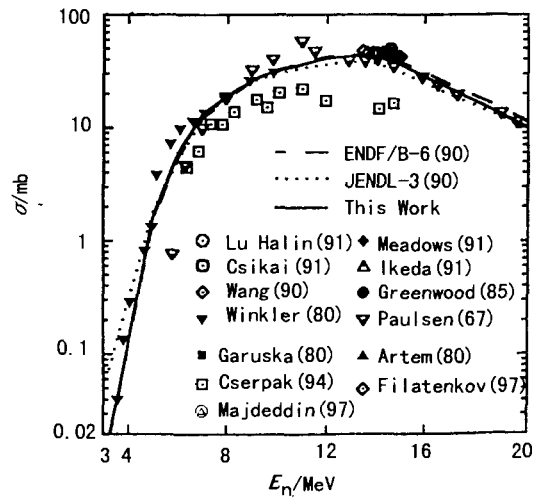

Fig. 1 (n,α) cross section for ^{63}Cu

2 $^{65}Cu(n,\alpha)^{62}Co$ Reaction

The experimental data were measured by Majdeddin(97), Molla(94), Cserpak(94), Gruzdevich(93), Mclane(88) and Clator(69)[14~17] from 6.32 to 16.7 MeV, respectively. The evaluated data were obtained by fitting experimental data from threshold energy to 14.0 MeV. Above 14.0MeV, the recommended data were taken from calculated result, and normalized to the fitting experimental datum of 11.6 mb at 14.0 MeV. The evaluated results are shown in Fig. 2.

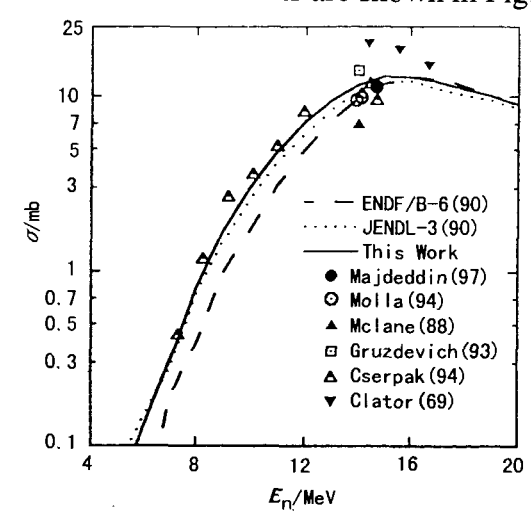

Fig. 2 (n,α) cross section for ^{65}Cu

3 $^{63}Cu(n,n'\alpha)^{59}Co$ Reaction

For (n,n'α) reaction, the recommended data were taken from calculated result due to lack of the experimental data(see Fig. 3).

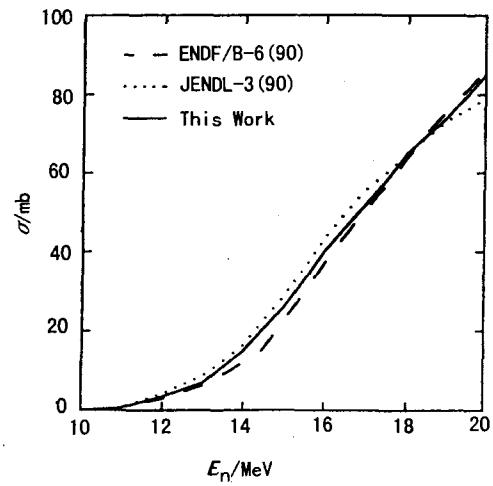

Fig. 3 (n,n'α) cross section for ^{63}Cu

4 $^{65}Cu(n,n'\alpha)^{61}Co$ Reaction

The experimental data were measured by Ryves(78), Qaim(74), Santry(65), Bramlitt(63) and Kantele(62)[18-22] from 13.58 to 19.8 MeV. The evaluated data were obtained by fitting experimental data from threshold energy to 20.0 MeV. The comparison of experimental data with evaluated ones is shown in Fig. 4.

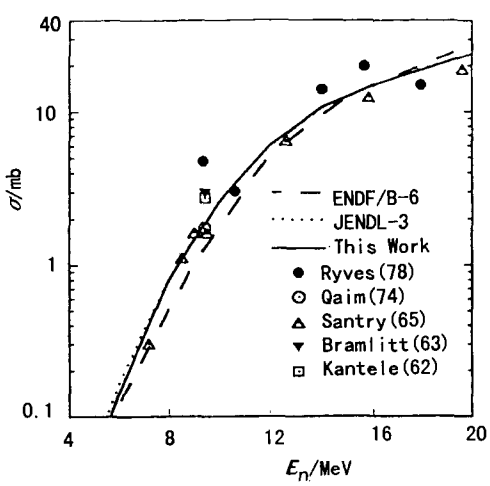

Fig. 4 (n,n'α) cross section for ^{65}Cu

5 The (n, α) and (n,n'α) Reaction for Natural Copper

For (n, α) reaction, there is only a datum measured by Majdeddin(97) at 14.7 MeV. For (n,n'α) reaction, there are no experimental data. The recommended data were obtained from summing the isotopic data weighted by the abundance. The comparison of other evaluated data with present evaluated data is shown in Figs. 5 ~ 6.

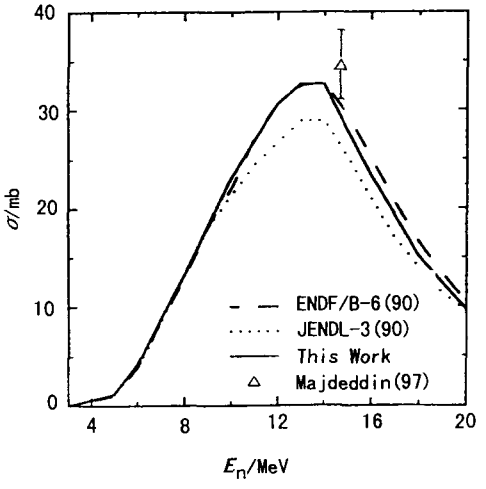

Fig. 5 (n,α) cross section for ^{Nat}Cu

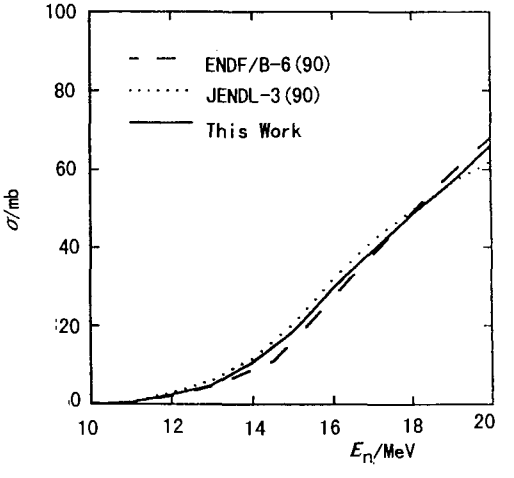

Fig. 6 (n,n'α) cross section for ^{Nat}Cu

6 Summary

The $^{63,65,Nat}Cu(n,\alpha)$ and $(n,n'\alpha)$ cross sections below 20.0 MeV were evaluated and compared with ENDF/B-6 and JEENDL-3. It was shown that our results have improved representation of experimental data.

Acknowledgement

The authors would like to thank Dr. Yu Baosheng for helpful discussion and suggestions.

References

[1] Zhang Jingshang. Nucl. Sci. Eng., 114, 55 (1993)
[2] A. D. Majdeddin et al., INDC(HUN)-031 (1997)
[3] Lu Hanlin et al., CNDP, No. 13, 80 (1995)
[4] J. W. Meadows et al., INDC(NDS)-286 (1993)
[5] J. Csikai et al., INDC-263-9 (1991)
[6] Y. Ikeda et al., INDC-263-9 (1991)
[7] Wang Yongchang et al., J. of Chinese High Ener. Phys. and Nucl. Phys., 14, 919 (1990)
[8] L. R. Greenwood et al., DOE-ER-006-21 (1985)
[9] G. Winkler et al., Nucl. Sci. Eng., 76, 30 (1980)
[10] U. Garuska et al., EXFOR Data No. 30553004 (1980)
[11] O. I. Artem et al., Atomic Energy, 49, 195 (1980)
[12] A. Paulsen et al., EXFOR Data No. 20388004 (1967)
[13] F. Cserpak et al., Phys. Rev., C49, 1525 (1994)
[14] N. I. Molla et al., Proc. of Conf. on Nucl. Data for Sci. And Tech., 2, 938 (1994) Gatlinburg, U. S. A.
[15] O. T. Gruzdevich et al., Ins. of Phys. and Power Eng., Obninsk, Russia (1993)
[16] V. Mclane et al., Neutron Cross Sections, Vol. 2, Boston (1988)
[17] Clator et al., Da/B 30, 2850; EXFOR Data No. 11536005 (1969)
[18] Ryves et al., NET 14 (3), 127 (1978)
[19] S. M. Qaim et al., EUR-5182E, 939(1974)
[20] D. C. Santry et al., Canadian Journal of Physics, 44, 1183 (1965)
[21] Bramlitt et al., Phys. Rev., 131, 2649 (1963)
[22] Kantele et al., Nucl. Phys., 35, 353 (1962)