# Cross Section calculation of Hf-178 and Hf-180

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## 1. Introduction

Cross sections are the first essence of testing the nuclear theory; they are also the basic data, which can be utilized in nuclear technology and nuclear power; and, therefore, accurate measurement of them is very important [1, 2, 3]. During the last two decades, cross sections have been measured for elements and their isotopes for the radiation damage assessment of fusion related materials. (n, $\alpha$) activation cross section measurements has also been performed to improve the model calculations as well as to explain the observed systematic & isotopic dependence of (n, $\alpha$) cross sections. Cross-section data for neutron induced reactions at around 14MeV are important for the fusion reactor design. TALYS [4] is a nuclear reaction program which has been used for data evaluation [3]. The correct description of input parameters is pre-requisite to calculate the cross section with the required accuracy. Hafnium has a good absorption cross section for thermal neutrons and has excellent mechanical properties and is therefore used for reactor control rods. In the present, work (n, α) reactions cross-section have been calculated for Hf by using nuclear reaction model code TALYS-1.4 and compared these with the existing experimental data EXFOR as well as with evaluated data file ENDF/B-VII.0.

## 2. Methodology

TALYS code can be executed manually using script. If we have created our own working directory with an input file named e.g. input, then a TALYS calculation can be easily started with talys<input>output.

The structure of mandatory input file:

Projectile XX

Element XX

Mass XX

Energy XX

Here, for the calculations neutron is the projectile used, element is Hafnium with their isotopes (72-Hf-178, 180), Energy is the incident energy of neutron in MeV which is taken from threshold to 20MeV. Out of the various given modes in TALYS, we used Exciton model in Preeqmode 2. We have also used ldmodel 2 which is Fermi back shifted model.

## 3. Results and Discussions

Fig1. show a very good agreement exists between present results and the data of C. Konno et al. [5, 6, 7] from 1994, the data X. Kong et al. from 1998 and the data C. Konno et al.1990 for the $^{180}$Hf (n, α) $^{177}$Yb reaction [5, 6, 7] around 15 MeV. Data library values of ENDF/B-VII.1 and evaluated nuclear data also good agreement with our calculated values with pre-equilibrium exciton model up to around 15 MeV. It also shows calculated cross-section of $^{180}$Hf (n, α) $^{177}$Yb reaction, from threshold to 20 MeV. ENDF/B-VII.1 values are also in good agreement with our calculated values with pre-equilibrium exciton model. Fig2. show calculated cross-section of $^{178}$Hf (n,α) $^{175}$Yb reaction from threshold to 20 MeV.

For a large experimental data with recent one available that of Xiangzhong Kong *et al*. (1998) [5, 6, 7] shows a close agreement with the present work. ENDF/B-VII.1 is also in good agreement with our calculated values with pre-equilibrium exciton model.

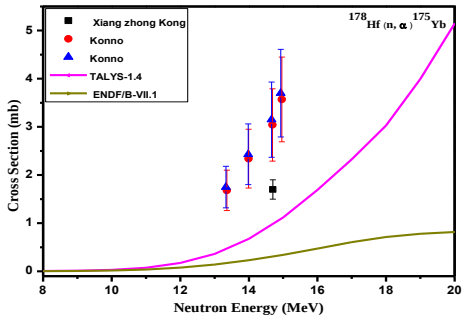


**Fig1.** Reaction cross-section vs. Neutron energy.

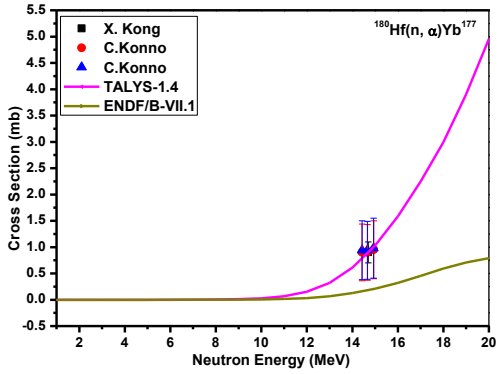


**Fig2.** Reaction cross-section vs. Neutron energy.

## 4. Conclusion

With increasing significance of consistent theoretical prediction of neutron data for different applications, the demand for accurate computer codes and correct parameterizations for different reaction channels has been increasing in recent years. In the present work an important improvement in description of (n, α) cross section has been obtained. From the result obtained for (n, α) reaction cross-section it is concluded that Back-shifted Fermi gas model level density calculations is appropriate for the studied nuclides. It is further concluded that the pre-equilibrium exciton model is suitable to calculate pre-equilibrium contribution to total (n, $\alpha$) reaction cross-section.

## References

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