CALCULATION AND STUDY OF 14 MeV NEUTRON ATTENUATION COEFFICIENTS IN A DOUBLE AXIS ROTATIONAL SYSTEM

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The neutron attenuation coefficient is determined in a double axis rotational system. The difference between a fixed system and a double axis rotational system is shown and curves for the neutron attenuation coefficient for the last case are drawn. The attenuated flux inside the sample is also drawn.

Introduction

The neutron attenuation coefficient or neutron self-shielding of a fixed sample in a 14 MeV neutron flux can be determined easily by using removal cross-section theory. The self-shielding is defined as the ratio of the activity induced inside the sample or the standard and the activity which would be induced if there were no attenuation: $\chi = I_{\text{att.}} / I_{\text{non att.}}$. Since we use nonidentical samples and standards in 14 MeV neutron activation analysis, the present study is necessary for the cases where a double axis rotational system is used.

The double axis rotational system

In 14 MeV neutron activation analysis, it is interesting to rotate the sample with respect to the neutron source whenever the space distribution of the neutron flux is a function of time and space coordinates. A single or double axis rotational system may be used and the rotation is made around the axis of the neutron source or the axis of the sample. The system shown in Fig. 1 is the well known double axis rotational system. Both the sample and the reference are rotated around the axis of the neutron source: the sample and the reference thus take successively the same place in space and receive on the average the same flux. The rotation of the sample and the reference around their own axes diminishes the undesirable effect produced by the presence of inhomogeneities inside the sample.
The removal cross-section theory

In order to calculate the flux at any point inside the sample, we use removal cross-section theory instead of the Monte-Carlo simulation technique, consisting of following the history of every selected neutron inside the sample. The application of removal cross-section theory to 14 MeV neutron activation analysis is justified for the following reasons:

1. The dimensions of the samples used are relatively small.
2. The functions $\sigma_i$ representing the cross-sections of interactions of 14 MeV neutrons with the material of the sample are smooth and have no resonances.
3. The values of the neutron attenuation coefficient inside the samples considered are small (a few percent).
4. The use of removal cross-section theory results in extensive simplifications for the computational work.
5. From the practical point of view the use of removal cross-section $\Sigma$ is equivalent to using a semi-empirical method since the value of $\Sigma$ is determined experimentally. We then calculate the neutron self-shielding for the different cases.