Study of sample shape effects on neutron resonance transmission analysis

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Abstracts

In order to study how the sample shape affects measurements of neutron resonance transmission analysis (NRTA), experiments with a copper bar sample with different rotation angles were done at a neutron Time-Of-Flight (TOF) facility GELINA (Belgium). It was found that models proposed to analyse the NRTA data for irregular shaped samples could well reproduce experimental data.

Keywords：neutron resonance transmission analysis, resonance analysis code

1. Introduction

NRTA is a non-destructive assay technique with potential to quantify special nuclear materials in nuclear-fuel debris or spent fuel. NRTA is based on the transmission experiments in which homogeneous samples with a constant thickness are used. However, spent fuel and, especially debris, are presented in irregular shapes that affect the NRTA measurements. In order to investigate the influence of irregular-shaped samples in the NRTA, Harada et al. [1] have proposed analytical models which consider a variable shape and a hole fraction. In this work, we report how the proposed models are applied to a real NRTA experiment with a Cu bar sample.

2. Experiments

The NRTA experiments were carried out at a 50-m flight path station of the neutron TOF-facility of GELINA, Belgium. A Cu-bar sample (width 1 cm, length 1 cm, height 10 cm) was used in the experiments. In order to simulate an irregular-shaped sample, the Cu bar was measured with different rotation angles with respect to the neutron beam. Neutrons passing through the sample were detected by a Li-glass scintillation detector that provided the TOF spectra.

3. Results & discussions

Figure 1 shows a transmission spectrum for the Cu bar with no rotation (0 deg relative to neutron beams). It was found that the experimental transmission (green) was able to be well fitted by considering the hole-fraction ‘fh’ (red). Figure 2 represents a transmission spectrum for the Cu bar with a rotation angle of 45 deg (green). For comparison, two analytical models proposed in Ref. [1] are shown; one considers only the hole fraction (blue; method1) and the other an irregularity (red; method2) as well. This result confirmed that the model proposed in Ref. [1] could reproduce the present experimental data.

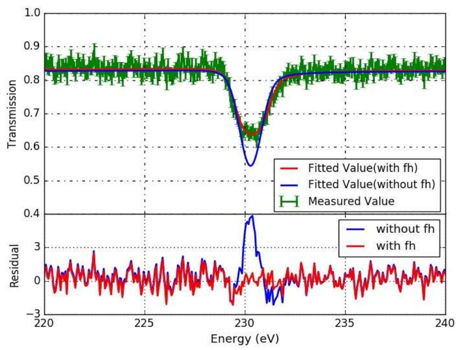

Figure 1. Top: Experimental transmission spectrum (green) for the Cu bar with no rotation. Bottom: Residuals between the measured values and model ones.

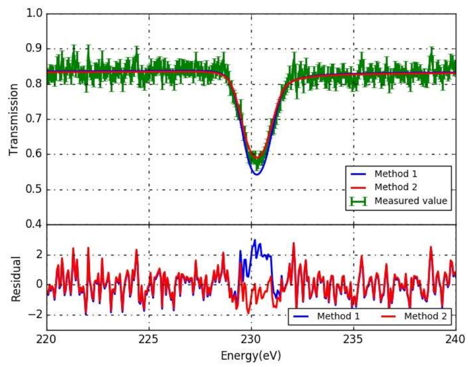

Figure 2. The same as Fig.1 but for Cu bar rotated by 45 deg.

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References:

[1] H. Harada et al., Journal of Nuclear Science and Technology, 52, No.6, 837-843 (2015).