

Influence of detector electronics on lanthanide's K-emission measurements

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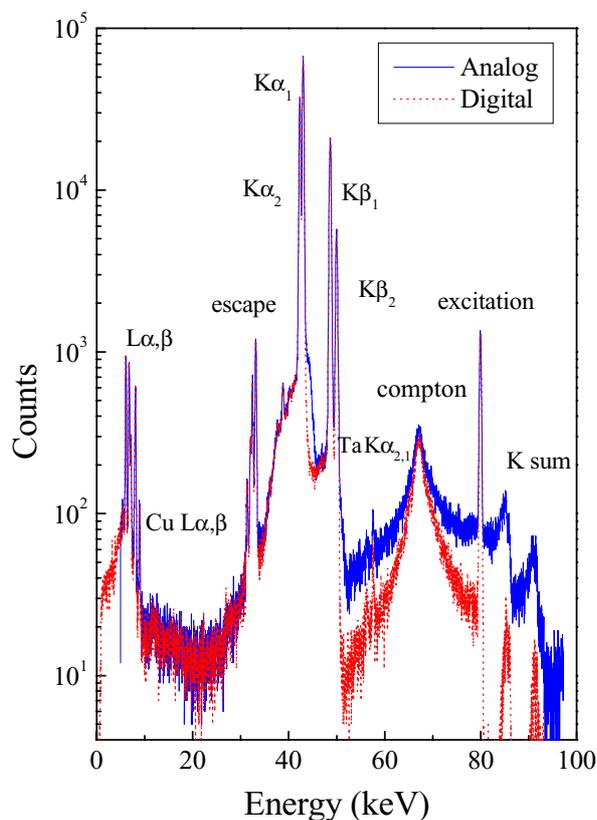
Introduction

X-ray emission spectra should imply the chemical information of the specific elements in the materials [1]. To analyze lanthanide's K-emission spectra for this purpose, however, a detector with high accuracy and precision in spectral intensity is required, as well as a highly brilliant X-ray source, in high-energy X-ray regions [2,3]. This report describes the results obtained from using conventional analog and digital detector electronics.

Experimental

X-ray fluorescence (XRF) spectra were collected by an energy-dispersive spectrometer when the storage ring was operated at 3 GeV (ring current of 150-200mA). The excitation energy was set at 80 keV using a Si(553) monochromator, and collimated by a 1.3mm ϕ collimator. The fluorescent X-rays were observed by a Ge detector (Canberra GL0055PS) in the perpendicular direction.

The detector signal was processed simultaneously by analog and digital electronics. While the analog electronics consisted of a spectroscopy amplifier (Canberra 2021, shaping time 12 μ s) and a multi-channel analyzer (SEIKO MCA7700), the digital electronics consisted of just one digital signal processor unit (ORTEC DSPEC Jr, rising time 20 μ s).



Results and Discussion

The XRF spectra of Gd metal plate (50mm \times 50mm \times 3mm t) are shown in Fig 1. The accumulation time was 1800 seconds, and the dead time was 13% at 1400 cps for both types of electronics. All the emission lines were assigned as indicated in Fig. 1. The Compton peak of the 80 keV excitation line is observed at around 68 keV. The Gd K-lines are observed, but their separation is not perfect due to the rather poor energy resolution. The energy resolution at 49 keV (GdK β_1) is 395 eV and 386 eV for the analog and digital electronics, respectively. In addition, Ge K escape peaks and parasitic lines originating from Cu and Ta can be seen.

Here it should be noted that the spectral distortions are observed in the spectrum measured with the analog electronics. The shoulder-like distortions are conspicuous on the higher energy side of Gd K-lines. Consequently there arises a counting rate dependence of K-line intensity ratio. The intensity ratio of K β_2 /(K β_1 +K β_2), for example, increases with the counting rate for the analog electronics, while it is almost constant for the digital electronics, as shown in Fig. 2. Therefore, the digital electronics used have proved useful for measurements with high accuracy and precision, like chemical speciation by lanthanide's K-emission. The authors would like to thank Prof. S. Kishimoto for his kind assistance during the experiment.

References

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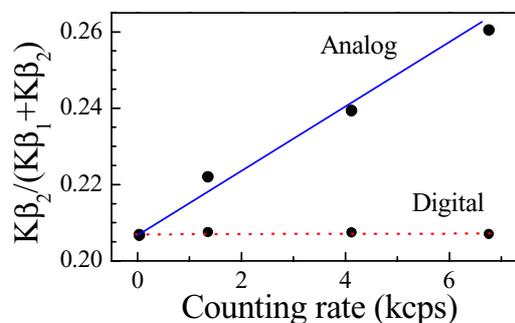


Figure 1 (left) High-energy XRF spectra of Gd metal. Figure 2 (right) Counting rate dependence of K β line intensity.