Elemental Analysis by Muonic X-ray Spectroscopy for Japanese Bronze Coins

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Negative muon irradiation to a bulk material enables non-destructive multi-elemental analysis. This method is based on the measurement of characteristic muonic X-rays emitted after muonic atom formation inside a material [1].

In this work, we performed muon irradiations to two Bronze coins using intense pulsed muon beam source at the muon facility in J-PARC/MLF. The picture of the samples (Tempo-Tsuho coins) is shown in Figure 1. The appearances of these coins are very similar to each other, but the right one is a counterfeit coin made by a feudal domain in Mito.

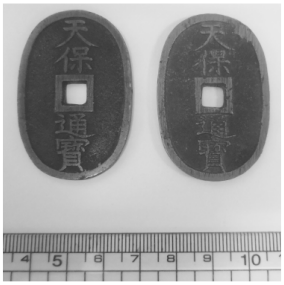

Fig. 1 : Picture of the Tempo-Tsuho coins (19 century, Japan). The left one is authentic coin made by shogun (Edo) and the other is a counterfeit coin by a feudal domain in Mito.

The intensity of muonic X-rays corresponds to the number of captured muons in each element, that is, the elemental composition of the sample. From muonic X-ray spectra (see Figure 2), we found each coin mainly made by Cu, Sn and Pb. We also investigated the difference of the elemental compositions between two coins quantitatively without sample destruction.

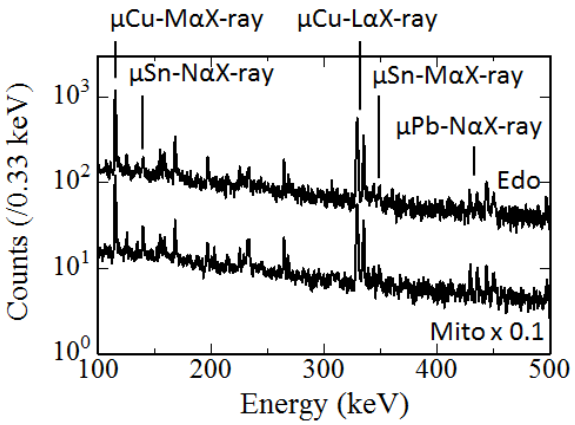

Fig. 2 : Muonic X-ray spectra of Tempo-Tsuho coins.

References

[1] K. Ninomiya *et. al.*, Bull. Chem. Soc. Jpn., **85**, 228 (2012)