

Development of Nondestructive Imaging Analysis Method Using Muonic X-Ray with a Double-Sided Silicon Strip Detector

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Abstract : In recent years, a nondestructive elemental analysis method based on muonic X-ray measurements has been developed and applied for various samples. Muonic X-rays are emitted after the formation of a muonic atom, which occurs when a negatively charged muon is captured in a muon atomic orbit around the nucleus. Because muonic X-rays have higher energy than electronic X-rays due to the muon mass, they can be measured without being absorbed by a material. Thus, estimating the two-dimensional (2D) elemental distribution of a sample became possible using an X-ray imaging detector. In this work, we report a non-destructive imaging experiment using muonic X-rays at Japan Proton Accelerator Research Complex. The irradiated target consisted of polypropylene material, and a double-sided silicon strip detector, which was developed as an imaging detector for astronomical observation, was employed. A peak corresponding to muonic X-rays from the carbon atoms in the target was clearly observed in the energy spectrum at an energy of 14 keV, and 2D visualizations were successfully reconstructed to reveal the projection image from the target. This result demonstrates the potential of the non-destructive elemental imaging method that is based on muonic X-ray measurement. To obtain a higher position resolution for imaging a smaller target, a new detector system will be developed to improve the statistical analysis in further research.

Keywords : DSSD, muon, muonic X-ray, imaging, non-destructive analysis

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