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Mossbauer microspectroscopy for geosciences

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Fe^{2+}/Fe^{3+} ratio in minerals is an important geosciences' information, because the ratio suggests oxygen fugacities of the mineral formation, high or low temperature oxidation after crystallization, and weathering. Mossbauer spectroscopy is a major method to detect Fe^{2+} and Fe^{3+} in minerals without chemically decomposing analyses. Mossbauer spectroscopy is a recoil-less atomic nuclear gamma ray resonance. Although Mossbauer spectroscopy is a very useful method, it was not applied to microspectroscopy. This is because there was no way to focus gamma ray. Recently, multi-capillary X-ray lense (MCX) to focus X-ray was developed and applied to Mossbauer microspectroscopy (Yoshida and Soejima, 2010). The author also started to construct Mossbauer microspectrometer using MCX for the applications to geosciences. In this report, we introduce newly developed Mossbauer microspectrometer and gamma ray beam examination. Although Mossbauer spectrum of Fe foil at 0.5mm was confirmed to be measured by this Mossbauer microspectrometer, the following problem remains. The gamma ray of 121 keV due to a transition from the second to the first excited states radiates from the gamma ray source ^{57}Co in addition to the 14.4 keV due to the transition from the first to the ground states. The 121 keV gamma ray straightly transmits the MCX and activates a sample at the focus of MCX and cause X-ray fluorescence. The X-ray fluorescence results in background of gamma ray spectra. To cut of the 121 keV as possible, a pinhole plate of Pb needs to be placed at the focus of MCX. S/N ratio can be improved by the Pb pinhole. However, Pb-L fluorescence of 10.6 keV is added to gamma ray spectra. The 10.6 keV Pb-L line is closed to 14.4 keV and makes S/N worse. To solve S/N problem, we are optimizing optical paths of gamma ray of this Mossbauer microspectrometer.

Keywords: Mossbauer spectroscopy, microspectroscopy