Measurement of Continuous X-ray Polarization by 3D-printed Instrument

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The polarization of scattered X-rays was measured by using 3D-printed spectrometer without using high-power facilities. As polarizers, materials composed of light to heavy elements ($C_5O_2H_8$, Al_2O_3, Ti, Zr, Pb) were used whose ratio of an elastic and inelastic scattering cross section were different. With the use of a 3D printer, holders of devices were made, which could change the detection angle by every 30 degrees (Fig.1). The scattered X-ray intensity was measured changing the detection angle. A low-power X-ray tube, Ultra-Lite Magnum (Moxtek, USA. The maximum rated wattage is 4 watts. Target material is tungsten.) was operated at 25 kV and 20 μA. An SDD (RES-Lab, Japan) was used as the detector. The measurement time was 1000 seconds for each measurement. An acrylic plate was employed as the scattering analyzer. The degree of polarization was estimated from the measured X-ray spectra when the detection angles were 0 and 90 degrees (Fig.2). Scattered X-rays by light-element polarizers are more highly polarized than those by heavy-element polarizers. This result indicates that Compton scattering can produce highly polarized continuous X-rays [1].

[1] R.Tanaka, T.Sugino, D.Yamashita, N.Shimura, and J.Kawai, Analitika i Kontrol' **22**, 128 (2018).

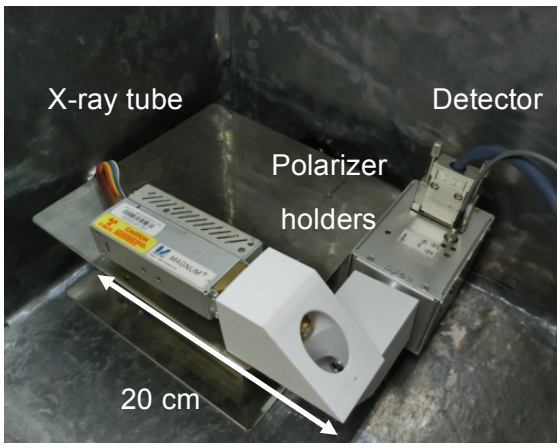

Fig.1 Experimental set up. 3D-printed holders can change the detection angle by every 30 degrees.

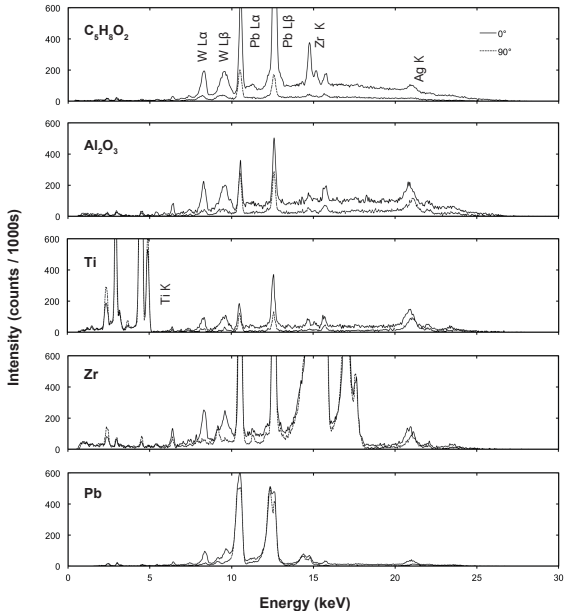

Fig.2 Measured X-ray spectra when using light- to heavy-element polarizers. Solid and dotted lines are for spectra when the detection angle are 0 and 90 degrees.