6 The Slow Positron Facility

6-1 Overview

The slow positron facility [1] is equipped with a dedicated 50 MeV linac, a slow positron generator, and a slow positron transport line with two branches. One of these branches leads to a positronium time-of-flight (Ps TOF) spectrometer and the other to a newly-developed transmission positron microscope (TPM).

The positron beam energy is adjustable from 0.1 eV to 35 eV. The pulse width, which is determined by the pulse width of the linac, is either 22 ns or 1 µs. The repetition rate is 50 Hz. The intensity of the slow positron beam is 1×10^{7} e^{+}/s and its diameter is 17 mm. The linac is operated in the 20 ns width mode for TOF experiments, and in the 1 µs width mode for TPM use.

6-2 Development of a Transmission Positron Microscope

In transmission positron microscopy an image is made of positrons emerging from the sample at near-zero scattering angles and with small energy losses. The material dependence of positron and electron transmittance has been investigated by comparing transmission images. Further, we have compared the diffraction patterns for positrons and electrons.

The positron microprobe is formed through the first focusing lens and a transmission-type brightness enhancement device [2, 3]. Through the deflector and the stigmator, it is connected to a conventional transmission electron microscope (TEM, JEM-1011B, JEOL). A positron or electron beam can be selected by a sector magnet installed at the top of the TEM. The electron beam is also utilized to adjust the optics system of the TEM in advance, before recording the TPM image. Transmission images and diffraction patterns for both positrons and electrons can be recorded and compared for the same region of a specimen.

We succeeded in recording transmission positron images for a Au[100] foil 10 nm thick at more than 3,000-fold magnification. The image required 12 hours of signal averaging to accumulate, but the condition of the optics was very stable. We also obtained diffraction patterns of the Au[100] foil using positron and electron beams, which are shown in Fig. 1. We compared the intensities of the spots for indices higher than {400} for Au[100] with the fcc structure obtained using positrons and electrons. The intensities of the higher-order spots for the positrons were higher than those for the electrons.

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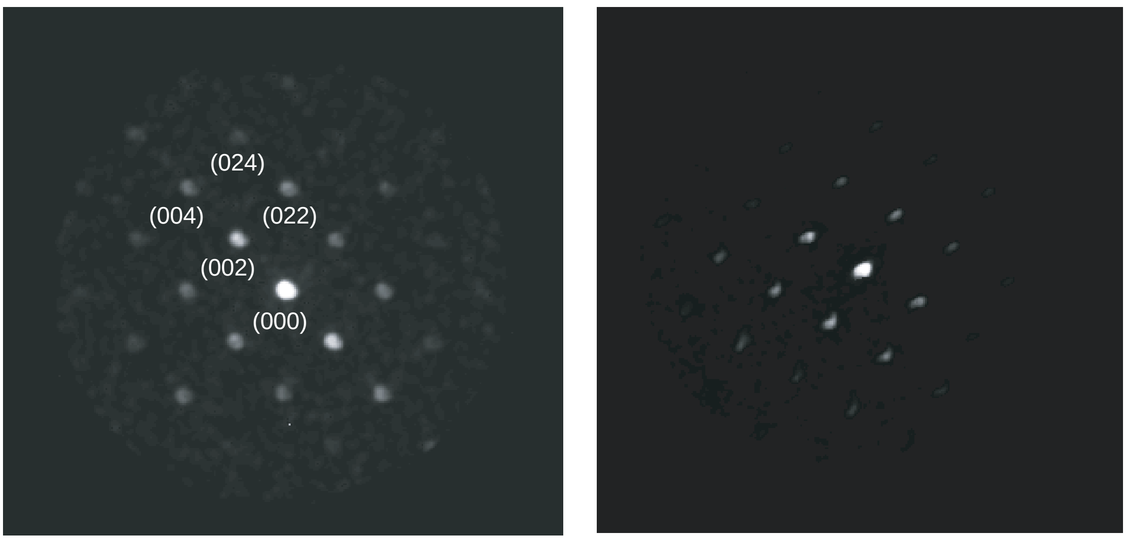

Figure 1
Diffraction patterns for crystal orientation [100] of a 10 nm thick Au single crystal foil obtained using positrons and electrons.