P26 | Surface Studies at SPF, KEK: Positron Diffraction and Positronium TOF

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Recent Surface studies at the Positron Facility (SPF) in IMSS, KEK are reported. The slow-positron beams of intensity 5×10^7/s in the long-pulse mode (width 1.2 μs) and 5×10^6/s in the short- pulse mode (1-10 ns, variable) are stably used.

1. Positron diffraction: Total-reflection high-energy positron diffraction (THREPD) is a unique method exceedingly sensitive to the atomic geometry of the topmost- and immediate sub-surface [1,2]. Recent results using the long-pulse mode positron beam are the etermination of the graphene-substrate distance where the substrates are Cu(111) and Co(0001)[3], and the detection of an asymmetric buckling structure of germanene on Al(111)[4]. It also determined a surface atomic structure of rutile-TiO 2 (110)(1×2), which had been debated for more than 30 years [5].

A low-energy positron diffraction (LEPD) station using the long-pulse mode positron beam has been constructed and a diffraction pattern from Ge(001)(2×1) surface was observed. The pattern is recorded by a delay-line detector (DLD). Since a DLD does not accept too many positrons in a short pulse, a technique has been developed to stretch the 1μs pulse to an appropriate width up to 20ms.

2. Positronium time-of-flight (Ps-TOF): Ps-TOF station is operated with the beam in the short pulse mode whose width is short enough for the measurement of TOF of the ortho-Ps whose lifetime is 142μs. For metals, in particular, the spectrum carries information on the electronic state of the surface exclusively, because Ps does not form in the bulk and thus it is certain that the Ps emitted is formed on the very surface. Recently it was observed that coating of W surface with alkali metals greatly enhanced the Ps emission from the surface [6]. The energy spectra show evidence of energy loss compared to that of the Ps emitted from a clean W surface.

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