Slow Positron Facility at IMSS Photon Factory

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The Slow Positron Facility (SPF) at High Energy Accelerator Organization (KEK) is a part of Photon Factory (PF) of the Institute of Material Structure Science (IMSS). It is a user dedicated facility with an energy tunable (0.1 - 35 keV) pulsed slow positron beam produced by a dedicated 55MeV linac. The beam line branches have been used for the positronium time-of-flight (Ps-TOF) measurements and the transmission positron microscope.

This year the slow positron generator (converter/moderator) system has been modified with a result of an order of magnitude increase of the slow positron intensity. This makes the accumulation of the statistics of the data much easier. Also this year a ^{22}Na-based slow positron beam system has been transferred from RIKEN. This machine will be used for the continuous (DC) slow positron beam applications and for the orientation training of those who are interested in beginning researches with a slow positron beam.

A remarkable scientific achievement this year is the success of the observation of the photo-detachment of the positronium negative ion (Ps^-) by Prof. Nagashima and co-workers. Nagashima developed a method of creating a high fraction (1%) of Ps^- by bombarding positrons on an alkali metal coated W[1]. The Ps^- is accelerated by an electric field and blue-shifted annihilation γ-rays from the moving Ps^- give a clear evidence for their existence. The photo-detachment is performed by using the pulsed positron beam of this facility and an intense Q-switched ND:YAG laser beam synchronized to the positron bunch [2]. Observed reduction of the Doppler shifted Ps^- signal indicates that the Ps^- ions are converted into neutral Ps, of which 3/4 is *ortho*-Ps which does not annihilate into 2γ [3]. During the forthcoming machine-times it is planned to measure the cross section of the photo-detachment process and compare with the theory.

A reflection high-energy positron diffraction (RHEPD [4,5]) measurement station has been installed this year by Dr. Kawasuso and co-workers and ready to be used for the measurements. High intensity of the positron beam of this facility is expected to improve the statistics of their data drastically. Experiments planned include (i) observation of weak RHEPD spots resulting from the formation of super-lattice structures on the topmost Si(111)-7x7 surface, (ii) RHEPD determination of the atomic positions on low-dimensional surfaces, (iii) investigation the formation of the charge density waves on surface phase transitions, (iv) observation of the spin splitting due to the surface Rashba effect, (v) observation of the RHEPD patterns from the reconstructed surface at various incident conditions, and (vi) direct determination of the atomic positions on the topmost surface using the Patterson function.

[1] Y. Nagashima, T. Hakodate, A. Miyamoto, *et al.*, *New J. Phys.* **10** (2008) 123029.
[2] T. Tachibana, K. Michishio, H. Terabe, *et al.*, *Nucl. Instr. and Meth. in Phys. Res.* A **621** (2010) 670.
[3] K. Michishio, T. Tachibana, H. Terabe, *et al.*, in preparation.
[4] A. Kawasuso and S. Okada, *Phys. Rev. Lett.* **81** (1998) 2695.
[5] Y. Fukaya, A. Kawasuso and A. Ichimiya, *Phys. Rev.* B **79** (2009) 193310.