Na-22 based low-energy AMOC measurements for chemical analysis of the free-volume holes in hydrocarbon-silica hybrid thin films

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Our group has so far proved that the positron and positronium (Ps) momentum distributions for polymers associate with their constituent elements [1,2], indicating that Ps is also useful for probing the chemistry of free-volume surfaces. The chemical environment from a nanoscopic viewpoint has been investigated for bulk polymers by means of the positron age-momentum correlation (AMOC) technique, which demonstrated the applicability of AMOC to chemical analysis around the free volumes [3]. In the present work, an energy-tunable AMOC measurement system with a Na-22-based pulsed positron beam was developed for investigating functional thin materials (Figure) [4]. Results of AMOC measurements using the developed system for hydrocarbon-silica hybrid thin films, fabricated through plasma-enhanced chemical vapor deposition [5], are demonstrated, and the effect of the decomposition of the hydrocarbon components on the free-volume structure is discussed based on the obtained AMOC data.

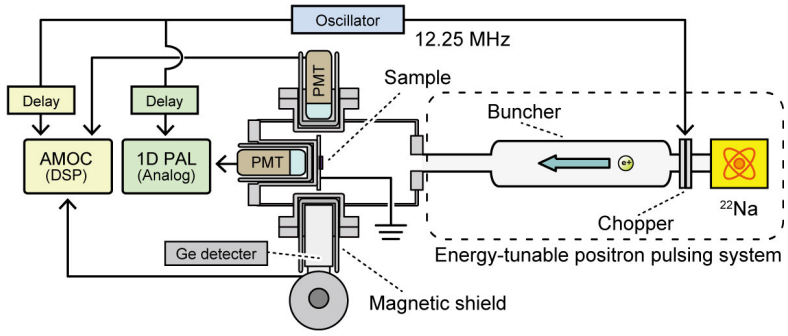

Figure: Schematics of the developed low-energy AMOC system Ref. [3].

This work was achieved with tremendous help of technical suggestions and continuous encouragements from the AIST positron team as follows; Dr. Yoshinori Kobayashi, Dr. Ryoichi Suzuki, Dr. Nagayasu Oshima, Dr. Brian O'Rourke, Dr. Hideaki Hagihara, and Dr. Hiroshi Yanagishita. Technical support from TechnoAP and FUJI IMVAC for the construction of the AMOC system is acknowledged. This work was supported by JSPS KAKENHI Grant Number 16H04526.

References:

[1] K. Ito, Y. Kobayashi, A. Nanasawa, Appl. Phys. Lett., 82 (2003) 654.
[2] K. Sato, K. Ito, K. Hirata, R. S. Yu, Y. Kobayashi, Phys. Rev. B, 71 (2005) 012201.
[3] K. Sato, H. Murakami, K. Ito, K. Hirata, Y. Kobayashi, Macromolecules, 42 (2009) 4853.
[4] K. Ito, JJAP Conf. Proc., 7 (2018) 011302.
[5] K. Ito, S. Yoshimoto, B. E. O'Rourke, N. Oshima, K. Kumagai, Appl. Phys. Lett., 112 (2018) 083701.

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