Multi-Probe Observation of Graphene-Metal Junction Devices: Structure and Magnetism at Interface

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Graphene has attracted much interest as next-generation materials such as the spintronics device. It is necessary to contact graphene with a metal in order to realize graphene-based devices, but few researches have been conducted to observe the interface states due to the lack of experimental techniques with atomic-layer depth resolution. Recently, IMSS, KEK has developed, in cooperation with JAEA and QST, the total-reflection high-energy positron diffraction (TRHEPD) method (Figure 1, left) using a high brightness positron beam that determines the structure of topmost- and immediate sub-surface atomic layers. By using the method, the structure of graphene-metal interface has been successfully observed [1]. In addition, a peculiar spin structure at the interface between graphene and a magnetic metal has been observed by using the soft X-ray depth-resolved X-ray magnetic circular dichroism (XMCD) method (Figure 2, right), which observes depth profile of the spin moment with atomic-layer resolution. These results were obtained owing to the world-highest effective intensity at the slow positron facility in IMSS and to the depth-resolved XMCD technique developed in IMSS.

From the TRHEPD and depth-resolved XMCD analyses, it has been revealed that the graphene-Co distance is shorter than that for graphene-Cu by more than 0.1 nm, and that the out-of-plane spin component exists at the interface between graphene and a magnetic Ni thin film. These results suggest a strong contribution of magnetism to the graphene-metal interaction, which leads to an important strategy to realize graphene-based devices. We will pursue the ways to improve the surface contact and the spin injection efficiency from the obtained results, and will possibly reveal the effect of magnetic fields on the interface contact, by using the TRHEPD and depth-resolved XMCD techniques including a recently-realized depth-resolved XMCD measurement in magnetic fields [3].

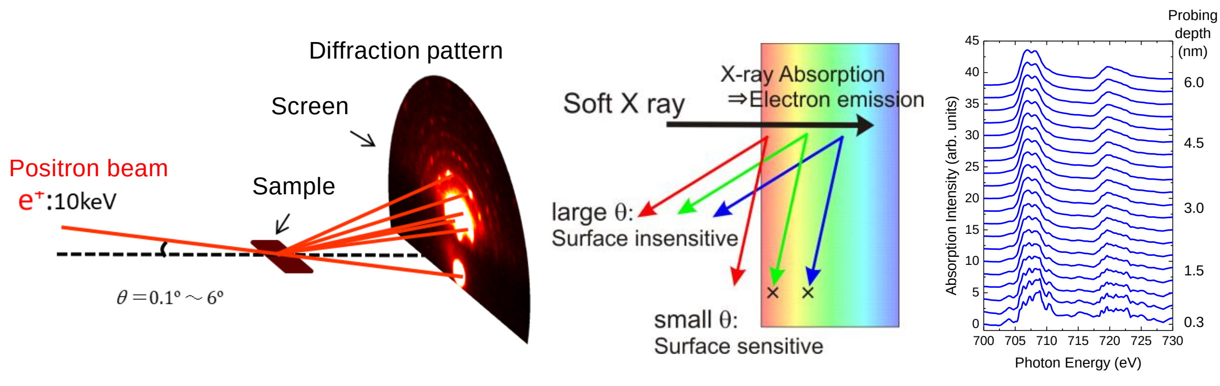

Fig. 1: TRHEPD (left) and Soft X-ray depth-resolved XMCD (right).

Bibliography

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