Investigation of J_c Properties in $Bi_2Sr_2Ca_{n-1}Cu_nO_y$ Superconducting Whisker using SR-XPS and HRTEM

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We grew Bi-based superconducting whiskers with various substitution ratio of Ca for Sr sites by ASGQP (an Al_2O_3-seeded glassy quenched platelet) method. Therefore, we found that only Bi-based superconducting whiskers whose Sr sites of 30% were occupied by Ca showed a high superconductive critical current density(:J_c) in the order of 2×10^5A/cm^2.

Moreover, we clarified chemical bond nature of as-grown Bi-based superconducting whiskers by high-energy X-ray photoemission spectroscopy using synchrotron radiation (SR-XPS). Therefore, we confirmed that Ca actually occupied Sr sites by existence of another XPS peak at higher binding energy of each Ca-2$p_{3/2,1/2}$ XPS spectrum (See Fig.2).

In addition, we also observed local structures of Bi-based superconducting whiskers by high-resolution transmission electron microscopy(HRTEM) in order to clarify an origin of the J_c enhancement. Therefore, we found that strains which were come from a smaller ion radius of Ca compared with one of Sr ion affected a lattice mismatch between CuO_2 plane and SrO plane in Bi-based superconductor and they forced to change modulation lengths in some unit cells. These strains seem to have worked as effective pinning centers in Bi-based superconducting whiskers.

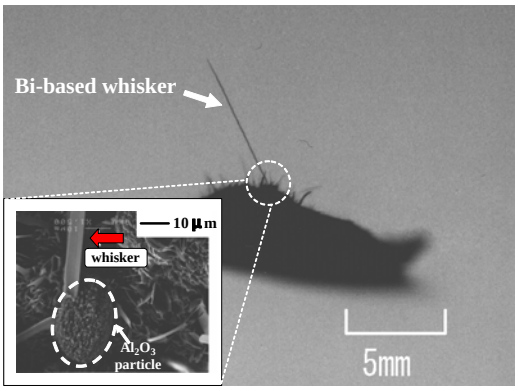

Fig.1 Optical photograph and SEM image of the grown whiskers.

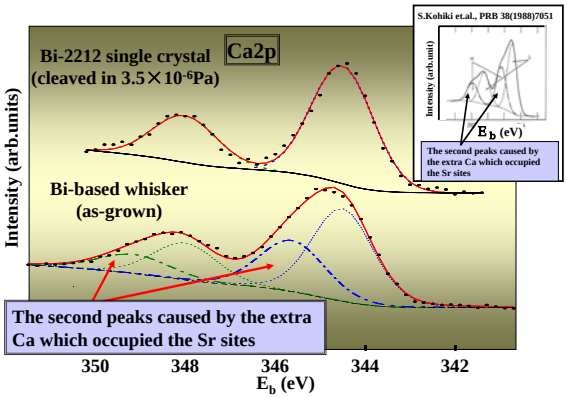

Fig.2 Ca-2p XPS spectrum obtained from the surface of the as-grown whiskers and the Bi-2212 single crystal cleaved in high vacuum(3.5×10^{-6}Pa) [hν=4750eV].