Physical Properties of High-Tc Thin Films Prepared by Molecular Beam EPITAXY

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It is widely accepted that thin-film fabrication is of great importance both for basic study and application. The most advantageous feature for thin-film studies is material parameters can be artificially controlled. Previous investigations have revealed that high-T_c cuprates have the following properties suitable for artificial control. (1) They show layer-by-layer growth, (2) the lattice mismatch between different high-T_c cuprates parallel to the CuO_2 plane is quite small (less than 3%) and (3) there are many kinds of crystal structures in superconducting cuprates and various combination with the CuO_2 planes and the blocking layers form high-T_c superconductors. From the viewpoint of the artificial control, molecular beam epitaxy (MBE) is more powerful than sputtering and laser ablation, because one can control the deposition rate even on an atomic scale by MBE.

We have been studying superconducting thin films of the Bi-based cuprates ($Bi_2Si_2Ca_{n-1}Cu_nO_{4+2n+6}$) prepared by MBE, and have reported the *in-situ* growth of superconducting films of n=1-5, nearly untwinned films on (Y,Nd)AlO_3, and supercondunсting ultrathin films. Here we report on the physical properties of heterostructural ultrathin films composed of the n=1 and n=2 phases.

The prepared thin films are schematically drawn in Fig.1, where each block of n=1 and n=2 represents a primitive cell with CuO_2 plane parallel to the substrate. We fixed the total number of the CuO_2 planes at six for all the samples. For example, the samples in the seris A consist of four primitive cells of n=1 and one for n=2, and those in the seris B consist of two primitive cells for n=1 and two for n=2.It should be noted that MBE system is most effective among thin-film growth methods for preparing such ultrathin films consisting of different materials and different sequences.

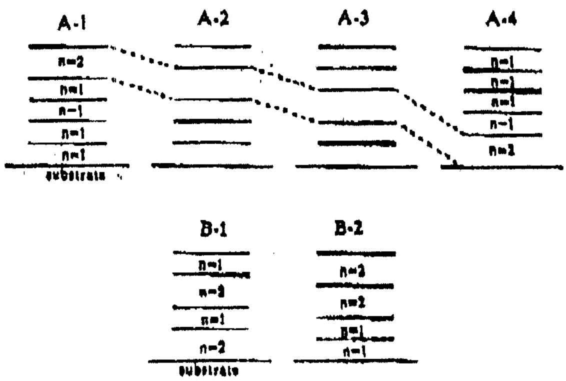

Fig. 1 The schematic of the prepared films.

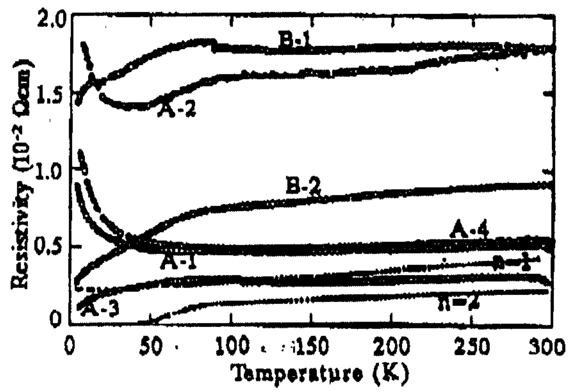

Fig. 2 The resistivity for the prepared films.

The prepared films were characterized by the reflection high enegy electron diffraction, x-ray diffraction and electron energy loss measurements, which have revealed that the structures of the films are well controlled by the MBE system. The resistivity of the prepared samples is shown in Fig.2, where the samples composed of a single component, *i.e.* six primitive cells of n=1 and three primitive cells of n=2, are shown for comparison. As is clearly seen, superconducting properties are different among the samples of the series A. The samples if A-1 and A-4, in which the n=2 block locates at the top/bottom layer, show no indication of superconductivity, whereas those of A-2 and A-3 become superconducting near 80K.these results sreongly suggest that the 80-K superconductivity occurs even in one primitive cell of n=2, and that superconducting properties are deteriorated at the top and bottom layers probably due to disorder and/or surface contamination.

In the Korean Vacuum Society meeting, we will discuss the structual, eletronic and optical properties of the fabricated films by comparing with the data for single crystals.