# Molecular Beam Epitaxial Growth of Oxide Single Crystal Films

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The growth of films have considerable interest in the field of superlattice structured multi-layer epitaxy led to realization of new devices concepts. Molecular beam epitaxy (MBE) with in situ observation by reflection high-energy electron diffraction (RHEED) is a key technology for controlled layered growth on the atomic scale in oxide crystal thin films. Also, the combination of radical oxygen source and MBE will certainly accelerate the progress of applications of oxides. In this study, the growth process of single crystal films using by MBE method is discussed taking the oxide materials of Bi-Sr-Ca-Cu family.

Oxidation was provided by a flux density of activated oxygen (oxygen radicals) from an rf-excited discharge. Generation of oxygen radicals is obtained in a specially designed radical sources with different types (coil and electrode types). Molecular oxygen was introduced into a quartz tube through a variable leak valve with mass flowmeter. Corresponding to the oxygen flow rate, the pressure of the system ranged from $1\times 10^{-6}$ Torr to $5\times 10^{-5}$ Torr. The base pressure was $1\times 10^{-10}$ Torr. The growth of Bi-oxides was achieved by coevaporation of metal elements and oxygen. In this way a Bi-oxide multilayer structure was prepared on a basal-plane MgO or $SrTiO_3$ substrate. The grown films compiled using RHEED patterns during and after the growth. Futher, the exact observation of oxygen radicals with MBE is an important technology for a approach of growth conditions on stoichiometry and perfection on the atomic scale in oxide. The oxidization degree, which is determined and controlled by the number of activated oxygen when using radical sources of two types, are utilized by voltage locked loop (VLL) method. Coil type is suitable for oxygen radical source than electrode type. The relationship between the flux of oxygen radical and the rf power or oxygen partial pressure estimated. The flux of radicals increases as the rf power increases, and indicates to the frequency change having the the value of about $2\times 10^{14}$ atoms · $cm^{-2}$ · $s^{-1}$ when the oxygen flow rate of 2.0 sccm and rf power 150 W.