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Laser MBE 장치를 이용한 $SrTiO_3$의 homoepitaxy

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Homoexpitaxy of $SrTiO_3$ by laser MBE system

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1. Introduction

The atomic scale control technique has been great attention not only for such devices as high T_c Josephson tunnel junction[1] but also for exploring a new materials in all fields such as spintronics. In particular, strontium titanate($SrTiO_3$) has been used most frequently as a substrate for thin films[2-4]. To design new artificial lattice, we need atomically flat and well defined surface. To synthesize atomically controlled layers on such substrate, we must able to *insitu* monitor the atomic layers. For these goal, we constructed laser MBE system and carried out SrTiO3 homoepitaxy to get atomically flat and grow layer controlled films by *insitu* RHEED monitering.

2. Experiment

The laser MBE system consists of main ultra-high vacuum(UHV) chamber that can keep base pressure of 10^{-10} Torr and preparation chamber. As oxidizing agent, No_2 and high purity O_2 gas can be sprayed on the substrate through a gas nozzle, controlling flow rate by variable leak valve or Mass Flow Controller(MFC). The substrate can be heated upto 1000°C by focused radiation from halogen lamp. The growth process is observed *insitu* by reflection high-energy electron diffraction(RHEED) in order to elucidate the growth mechanism at the

surface. Four multi target that is controlled its position by computer controlled step motor was rotated by D.C motor so that the laser beam always hits a fresh surface.

The (001) oriented $SrTiO_3$ substrates were pre-annealed at 1000°C for 10 hours, flowing O_2 gas by 200 CC/min to get atomically flat surfaces. The temperature of substrate during growing was keeped at 650°C under an oxygen pressure of $2,1x10^{-6}$ Torr. Single crystal $SrTiO_3$ was used as a target and RHEED pattern were monitored through a CCD camera when the intensity variation was analyzed by an image processor.

3. Result and discussion

Fine streaky RHEED patterns and RHEED intensity oscillations were observed throughout the homoepitaxial growth of $SrTiO_3$ films. Deposition rate was 0.012 nm/sec when the laser frequency was 4Hz. From the RHEED intensity oscillatio, we can confirm the layer by layer growth mode. At the top of oscillation, top layer is atomically flat TiO_2 layer and SrO layer at the bottom. The oscillation was persist about 100 period at the specular spot.

4. Conclusion

The RHEED intensity oscillation lasting more than 100 periods were observed during the homoepitaxial growth of $SrTiO_3$ on $SrTiO_3$(001) substrate. From this, we were able to control the atomic layer by *insitu* RHEED signal monitoring and get the vision of designing new artificial lattice that has a novel properties which can be applied to devices.

Reference

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