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Orientation controlled growth of underdoped $YBa_2Cu_3O_{7-\delta}$ thin films and their c-axis far infrared properties

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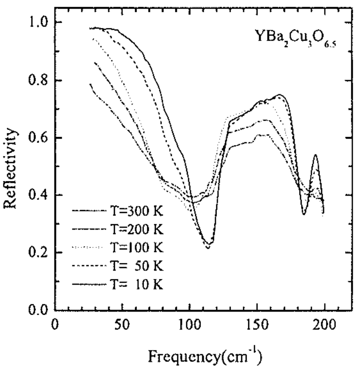
In-plane c-axis aligned (110) $YBa_2Cu_3O_{7-\delta}$ thin films on (110) $SrTiO_3$ substrates have been successfully fabricated by pulsed laser deposition, using the self-template method. The oxygen deficiency of the films is controlled in-situ by adjusting the annealing oxygen partial pressure P_{o2}. Both the in-plane epitaxy and twin formation in these films are influenced by P_{o2}. The films tend to have a structure in which the crystalline a and b axes are tilted about 0.5 degree away from the corresponding axes of the substrates, while keeping the (110) planes parallel to each other. A decrease in P_{o2} induces a reduction in twinning, which is finally suppressed in the film annealed at P_{o2}=600 mTorr. Our results suggest that twin formation during a tetragonal-to-orthorhombic transformation is controlled by the competition between the uniaxial force exerted at the interface by the vicinal substrate surface and the thermodynamic force resulted from the difference in lattice parameters for a and b axes of orthorhombic YBCO. c-axis far-infrared reflectivity measurements have been carried out on these films and it is revealed that in the normal state the carriers are confined in the CuO planes and that their transport across the c-axis is incoherent. Upon decreasing the temperature below the critical transition temperature T_c, coherence is built up for the carrier transportation along the c-axis and a reflectivity edge associated with the Josephson plasma is observed at around 110 cm^{-1}. A pseudogap develops in the normal state at temperatures well above T_c and it persists in the superconducting state.



c-axis far infrared reflectivity of an underdoped $YBa_2Cu_3O_{6.5}$ film at different temperatures.

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Spectroscopic Characterization of $Zn/Zn_{1-x}Mg_xO$ Multi-quantum Wells on Lattice-matched SCAM Substrates Fabricated by Combintorial Laser-MBE Techniques.

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Introduction High quality $ZnO/Zn_{1-x}Mg_xO$ multi-quantum wells have been successfully prepared on lattice-matched $ScAlMgO_4$ (0001) substrates by laser-MBE method. Nine pixels of quantum well samples with different well widths from 0.7 to 4.65 nm were integrated on the same substrate by using combinatorial techniques so that we can carry out the comparative studies on these samples systematically. In the present study, we investigate on a serial of multi-quantum well samples having 10 periods by spectroscopic measurements including absorption, photoluminescence excited by continuum He-Cd laser (325 nm), and stimulated emission. The Mg composition x in the barrier of investigated samples is chosen as 0.12, corresponding to the band-offset of 0.2 eV.

Results and Discussion All absorption spectra of nine pixels show sharp excitonic peaks at low temperatures. The resonant energy increases with decreasing well widths due to the quantum confinement effect. The well width dependence of the lowest transition energies is consistent with the numerical calculation based on the model of one-dimensional squared potential wells. The linewidth of absorption peak at 5 K also increases sensitively with decreasing well width, indicating that the inhomogeneous broadening results mainly from the fluctuation of well width. The homogeneous broadening induced by phonons is deduced from the temperature dependence of full width at half maximum of excitonic peaks. It is found that the coupling strength between excitons and LO-phonons in the quantum wells is much lower than that of bulk ZnO, and decreases as the well width decreases. The effective reduction of the coupling strength between excitons and LO-phonons is consistent with the enhancement of exciton binding energy due to the quantum confinement effect.

Stimulated emission spectra are measured under the excitation of dye laser with various intensities and temperatures. The stimulated emission in ZnO quantum wells is induced by exciton-exciton scattering (P-band), rather than the recombination of electron-hole plasma as in III-V group materials. The demonstration of exciton-related stimulated emission predicts the potential of realizing low-threshold lasing in this kind of quantum well materials. The exciton binding energy is determined by the energy separation between P-band and free exciton. The exciton binding energy in quantum well samples is considerably larger than that of bulk ZnO. This enhancement of binding energy is favorable to the reservation of exciton states, and hence to ensure exciton-related luminescence at high temperature.

Reference [1] H. D. Sun, T. Makino, N. T. Tuan, Y. Segawa, M. Kawasaki, A. Ohtomo, K. Tamura, and H. Koinuma, Appl. Phys. Lett. (Submitted). [2] H. D. Sun, T. Makino, N. T. Tuan, Y. Segawa, Z. K. Tang, G. K. L. Wong, M. Kawasaki, A. Ohtomo, K. Tamura, and H. Koinuma, Appl. Phys. Lett. (Submitted).