INTERNATIONAL UNION OF MATERIALS RESEARCH SOCIETIES

The Fifth IUMRS International Conference on Advanced Materials

IUMRS-ICAM'99

ABSTRACTS

(1)

Beijing, China
June 13- June 18, 1999

Organized By
C-MRS
Chinese Materials Research Society

N-08

DOSAGE AND STRAIN EFFECTS ON DIFFUSION INDUCED DISORDER IN InGaAsP MQW STRUCTURES DUE TO PLASMA IMMERSION ION IMPLANTATION OF ARGON

L.M. Lam, A.H.P. Ho, K.S. Chan, P.K. Chu and E.Y.B. Pun[†]
Department of Phsyics and Material Science
[†] Department of Electronic Engineering
City University of Hong Kong, 83 Tat Chee Avenue
Kowloon, Hong Kong Special Administration Region, China

Plasma immersion ion implantation (PIII) of Ar^+ combined with post-implant anneal has been demonstrated to be an effective way of introducing selective area bandgap tuning in InGaAsP MQW structures. Other techniques such as SiO_2 capping and direct laser heating have already been shown to be useful for fabrication of integrated optical devices. However these two methods lack precise control on the extent of the disorder. Our experiments demonstrate that one can control the disordering speed by simply varying the implantation dosage. This we believe should lead to better prospect of using the disordering technique for the fabrication of on-chip integrated optical devices.

In this paper, we report results of the PIII dosage effect on the disordering of strained (1.33μm) and non-strained (1.48μm) InGaAsP MQW structures. Room-temperature photoluminescence was used to assess the disorder inside the MQW structure. The samples were placed inside a chamber filled with Ar^+ plasma and -20kV pulses were applied to the sample stage, thus causing the Ar^+ ions to impinge into the sample surface. The calculated thickness of the Ar^+ implanted region was around 22nm. The subsequent anneal, which was performed at 650-700°C, would drive the defects deposited by the PIII process to diffuse into the MQW region. This hence led to the observed PL blue-shift due to the intermixing between the barriers and the quantum wells. The dosage was varied between 10^{13} and 10^{16} cm^{-3} by controlling the total pulse duration of the implantation voltage. We observe that an increase in PIII Ar^+ dosage gives rise to a larger blueshift in both strained and non-strained MQW structures. We attribute this effect to the increase of defect density under higher PIII Ar^+ dosage conditions. The relative magnitudes of blueshifts in the compressively strained and non-strained InGaAsP MQW structures are also compared. We observe that non-strained MQW structure has larger (20nm more) blueshift than the strained one. This we believe is related to the suppression of defect diffusion via the introduction of compressive strain within the lattice.

In summary our results reveal that the extent of disordering can be controlled by PIII Ar^+ dosage as well as lattice strain. This is indicative of the dependence of intermixing on the concentration and diffusion speed of PIII deposited defects. The material aspects of PIII into the MQW structures are currently being examined using cross-sectional TEM. The observed disorder may then be related to the generation of implantation defects and their diffusion during the subsequent anneal.

E-mail: A.H.P. Ho <apaho@cityu.edu.hk>

N-09

HIGH POWER AND TUNABLE SINGLE-MODE QUANTUM CASCADE LASERS

Claire Gmachl, Federico Capasso, Alessandro Tredicucci, Deborah L. Sivco, James N. Baillargeon, Albert L. Hutchinson, and Alfred Y. Cho
Bell Laboratories, Lucent Technologies,
600 Mountain Avenue, Murray Hill, NJ 07974, USA

Quantum cascade (QC) lasers are a fundamentally new semiconductor laser source designed by methods of "bandstructure engineering" and realized by molecular beam epitaxy (MBE). They are based on optical transitions between quantized states of the same band (quantum well intersubband transitions) and on the cascading scheme, where many (typically N = 25) active regions are stacked upon each other alternated with electron injection regions. Under an appropriate applied bias, the injectors connect the N active regions into one continuous cascade of optical transitions, allowing each electron above laser threshold to ideally create N laser-photons. Therefore, QC-lasers have an intrinsic potential for high optical output power. A second characteristic feature is the tailorability of the emission wavelength, which is primarily determined by the quantum wells