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EFFECT OF V/III RATIO ON THE OPTICAL PROPERTIES OF MOCVD GROWN UNDOPED GaAs LAYERS

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A detailed analysis of low temperature photoluminescence (PL) spectroscopy on undoped high quality GaAs is presented. For undoped GaAs epitaxial layers grown by low pressure metal organic chemical vapor deposition under different V/III ratios, an optimum ratio corresponding to a minimum number of shallow impurities was clearly identified. The V/III ratio has strong effect on the optical properties of undoped GaAs epitaxial layers. When the V/III ratio was varied from 45 to 87, the electron concentration, n, of undoped GaAs increased with increasing V/III ratio. Below the V/III ratio of 45 in our case, the sample exhibited a p-type behavior, which has been identified by photoluminescence as well as depth profiling by Electro-chemical Capacitance Voltage (ECV) profiler. © 1997 Published by Elsevier Science Ltd

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1. INTRODUCTION

Metal Organic Chemical Vapor Deposition (MOCVD) is well-known for the growth of epitaxial GaAs, related III–V compounds and their heterostructures. MOCVD has been successfully employed to grow high performance devices such as lasers, solar cells, MESFETs and QWs heterostructures, superlattices, HEMTs and other electronic and optoelectronic devices. Little understanding is evident in the literature of the effect of systematic variation of V/III ratio on the optical behavior in epi-GaAs film. Hence, the present paper reports the results from the effect of V/III ratio on the optical properties of undoped GaAs epitaxial layers by photoluminescence spectroscopy and determines an optimum V/III ratio for device quality epitaxial layers by MOCVD approach.

2. EXPERIMENTAL DETAILS

The undoped GaAs epitaxial layers were grown in low pressure horizontal MOCVD reactor. The source materials were trimethylgallium (TMGa), arsine (AsH_3, 100%) and palladium purified H_2 as a carrier gas. Both Cr-doped semi-insulating GaAs and Si-doped n^+GaAs (1 0 0) substrates (epi-ready) supplied by American Xtal Technology, offset by 2° towards [1 1 0] direction were used for epitaxial growth process. During the growth, the substrate temperature and pressure inside the reactor were kept at 700°C and 100 Torr, respectively. The TMGa flow rate was 10 SCCM and the AsH_3 flow rate was varied from 25 to 50 SCCM in order to obtain the different stoichiometric epilayers, to reach a total flow rate of 2 SLPM. The V/III ratios of the samples were varied from 21 to 87. The details of the growth procedure can be found elsewhere [1].

Photoluminescence (PL) measurements were carried out at 4.2 K using a MIDAC Fourier Transform PL (FTPL) system. An Argon ion laser operating at a wavelength of 5145 Å was used as a source of excitation. The exposed area was about 3 mm^2. The PL signal was detected by a LN_2 cooled Ge-Photodetector whose operating range is about 0.75–1.9 eV, while resolution was kept at 0.5 meV.

3. RESULTS AND DISCUSSION

The undoped GaAs epitaxial layers were characterized in terms of structures, surface morphology,

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