# Photoluminescence and Raman scattering in $In_{0.53}Ga_{0.47}As/InP:Dy$

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## ABSTRACT

High purity $In_{0.53}Ga_{0.47}As$ grown on InP by liquid phase epitaxy with small amounts of rare earth dysprosium (Dy) in the melt was investigated. The presence of Dy dramatically reduced the charge carrier and residual donor concentration, and shifted the low temperature photoluminescence peaks toward higher energies. Room temperature Raman spectra were also studied. The Raman shift of the GaAs-like longitudinal optical phonon band increased with the Dy content in the growth melt. The results were explained by the effect of gettering of unintentional donor impurities in the melt by Dy, as well as by the effect of strain modification in the layers due to the possible incorporation of Dy.

## 1. INTRODUCTION

High purity InP, InGaAs and InGaAsP can be grown by liquid phase epitaxy (LPE) with small amounts of rare earth elements (REE) as erbium (Er), dysprosium (Dy), ytterbium (Yb), praesodymium (Pr), samarium (Sm), gadolinium (Gd), etc., in the melt.[1,2,3,4,5,6] REEs form stable compounds with the donor impurities (Si, O, S, Se, Te), which are insoluble in the indium melt, preventing their incorporation into the grown layers, thus reducing the level of unintentional donor doping (gettering effect). REEs can also be incorporated into the lattice, which might modify the mismatch strains in the heteroepitaxial layer.

We have grown high purity $In_{0.53}Ga_{0.47}As$ layers on InP substrates by LPE. High purity was achieved by adding small amounts of REE dysprosium (Dy) to the melt. Here we present the results of a photoluminescence (PL) and Raman scattering study of properties of InGaAs layers on InP. The effects of the variation of the amount of Dy added to the melt were established. Some results of this work have been published elsewhere.[7,8]

## 2. LIQUID PHASE EPITAXIAL GROWTH AND CHARACTERIZATION

LPE $In_{0.53}Ga_{0.47}As$ layers were grown on (100) oriented semi-insulating InP:Fe substrates from indium melts with up to 0.15 atomic per cent Dy, in a conventional multiple-bin horizontal graphite slider boat and quartz tube apparatus in Pd-purified flowing hydrogen atmosphere. Details are described in our previous paper.[7] The layer thickness was 3-5 μm.

The grown layers were characterized by double-crystal X-ray diffraction (DCXRD), 300 K and 77 K Van der Pauw Hall and conductivity measurements, room temperature Raman scattering and low temperature photoluminescence measurements. Near-band-edge PL spectra, excited by a Kr ion laser, were recorded at 77 K and 4.4 K, using a 1 m monochromator coupled to a cooled Ge detector.[7,9] Unpolarized Stokes component Raman spectra, excited by the 514 nm line of an argon ion laser, have been taken in a quasi-backscattering geometry at room temperature.[8] A double grating spectrometer with a spectral resolution of 0.5 $cm^{-1}$, and standard photon counting techniques were used.

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