Opt Quant Electron (2013) 45:389–399
DOI 10.1007/s11082-012-9641-5

Large signal analysis of double quantum well transistor laser

Ashkan Horri · Rahim Faez

Received: 17 October 2012 / Accepted: 26 November 2012 / Published online: 13 December 2012

Abstract In this paper, we present an analytical model for the large-signal analysis of the double quantum well (DQW) transistor laser. Our model is based on solving the continuity equation and the rate equations which incorporate the virtual states as a conversion mechanism. By using the presented model, effects of barrier width on DQW transistor laser static and dynamic performances are investigated. Also the static and dynamic responses of DQW transistor lasers are compared with single quantum well ones. Simulation results are in agreement with the numerical and experimental results reported by other researchers.

Keywords Double quantum well (DQW) · Transistor laser (TL) · Barrier width

1 Introduction

The transistor laser (TL) is a unique device that operates simultaneously as a transistor and laser. The structure of a TL is similar to that of an n-p-n heterojunction bipolar transistor (Coldren and Corizne 1995; Shibata et al. 1985) with an active layer quantum well (QW) in the base region. Electrons injected from an emitter are diffused, and a portion of the electrons is recombined at the active layer while the rest are removed from the collector. With quantum wells incorporated in the base regions of bipolar transistors, the transistor laser possesses advantageous characteristics of high modulation bandwidth, fast spontaneous carrier lifetime and high differential optical gain (Shibata et al. 1985). Transistor lasers were proposed and demonstrated by Shibata et al. (1985). The potential for TLs to show high speed modulation and multifunctionality was presented (Feng et al. 2007). Also, the ability of nonlinear wave mixing and two different wavelengths radiation of transistor laser were

A. Horri (✉)
Young Researchers Club, Arak Branch, Islamic Azad University, Arak, Iran
e-mail: Ashkan_horri@yahoo.com

R. Faez
Department of Electrical Engineering, Sharif University of Technology, Tehran, Iran
e-mail: faez@sharif.edu