Opt Quant Electron (2013) 45:699–706
DOI 10.1007/s11082-013-9663-7

Physical modeling of an optical memory cell based on quantum dot-in-well hybrid structure

L. Ding · L. Fan · Y. Q. Li · F. M. Guo

Received: 28 September 2012 / Accepted: 6 February 2013 / Published online: 23 February 2013

Abstract In this paper we present a physical modeling and simulation result of an optical memory cell based on a semiconductor quantum-dot in quantum-well hybrid structure. The physical modeling and simulation were done in Crosslight Apsys software which offers advanced models for photoelectric devices. We have optimized the scan conditions, iterative algorithm and other simulation parameters in order to obtain a solution. The calculated I–V and C–V curves agree with the experimental results and demonstrate that the cell can be used for photon storage.

Keywords Photon storage · Quantum-dots · Quantum-well · APSYS · Physical model

1 Introduction

There has been great interest in studying the storage and retrieval of light (Zimmermann et al. 1999; Tao et al. 2000; Rocke et al. 1997; Schoenfeld et al. 1999; Hu et al. 2006). However, storing light for appreciable amounts of time is not an easy task. In principle, light can only be stored directly by guiding its path in a loop back to the origin. For example, in a cavity in which a light beam is folded back and forth between two mirrors or a whispering gallery–type resonator or by guiding the light along a coil of optical fiber. To reach delay times of the order of 1 millisecond, one must use mirrors that lose very little light to obtain the necessary 300 reflections in a 1 meter long cavity, or equivalently, one must use 300 m of fiber to form the loop (Zimmermann et al. 1999). Another more effective approach to light storage is the usage of semiconductor nanostructures such as optical memory cells. In such devices, incoming optical signals are first stored as spatially separated electron-hole pairs and then retrieved by bringing stored electrons and holes to recombine at the same location radiatively. Generally speaking, a normal memorizer requires over 10 million atoms for storage of a single bit

L. Ding · L. Fan · Y. Q. Li · F. M. Guo (✉)
Laboratory of Polar Materials and Devices, School of Information Science and Technology,
East China Normal University, No. 500, Dong Chuan Road, Shanghai 200241, People's Republic of China
e-mail: fmguo@ee.ecnu.edu.cn