Demonstration of the Growth of ZnCdTe/ZnTe Quantum Wells with Variable Composition by Submonolayer Pulsed Beam Epitaxy (SPBE)

Frantisek Sutara, Isaac Hernández-Calderón[+]
Physics Department, Cinvestav-IPN, Ave. IPN 2508, 07360 Mexico City, Mexico

The growth of specifically designed semiconductor heterostructures very often requires the growth of several quantum wells (QWs) with different alloy compositions. In the case of molecular beam epitaxy (MBE) and related techniques, the modification of the alloy composition is obtained by the change of the cell temperatures. Then, the growth process is interrupted to allow the modification of the growth parameters for each QW and the deposition process is restarted when the growth conditions reach stability. If many layers with different composition are required, the complexity and duration of the growth process becomes impractical. Submonolayer pulsed beam epitaxy (SPBE) has been employed to overcome those difficulties for the growth of ZnCdSe QWs [1]. SPBE allows the modification of the ternary alloy composition in real-time, without interruption of the growth process and without modification of the cell fluxes. SPBE is based on the pulsed supply of the reactant species and on the self-regulated process of the surface saturation, leading to a layer-by-layer growth mode with precise thickness control. Here, we demonstrate the successful application of SPBE to the growth of a single heterostructure containing three $Zn_{1-x}Cd_xTe$/ZnTe QWs with different composition, each 8 monolayers (MLs) thick; the QWs were grown on a GaAs (001) substrate at ~ 275 °C. All ZnTe layers were grown by MBE. The photoluminescence (PL) spectrum of the heterostructure acquired at 20 K exhibits three well defined emissions confirming the different composition of each ZnCdTe QW. A detailed explanation of the growth process and its advantages will be explained.

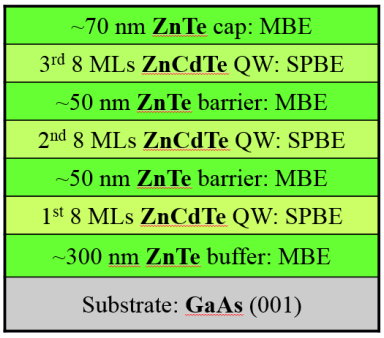

Figure 1. Heterostructure layout.

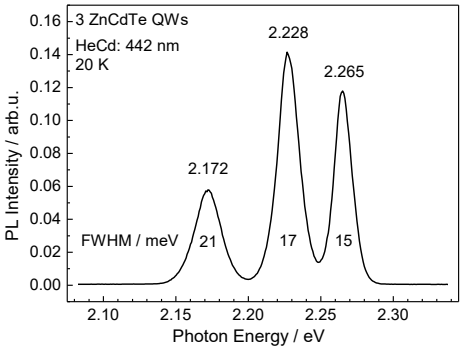

Figure 2. Low temperature PL spectrum of a heterostructure with 3 ZnCdTe QWs grown by SPBE in a layer-by-layer mode without growth interruption.

[1] I. Hernández-Calderón, "Epitaxial growth of thin films and quantum structures of II-VI visible-bandgap semiconductors," in Molecular Beam Epitaxy: From Research to Mass Production, edited by M. Henini (Elsevier, Oxford, 2013), pp. 310–346.

[+] Author for correspondence: Isaac.Hernández@fis.cinvestav.mx