Hole migration and optically induced charge depletion in GaSb/GaAs wetting layers and quantum rings

ABSTRACT

We present the results of photoluminescence (PL) measurements on a type-II GaSb/GaAs quantum dot/ring sample as a function of temperature (2 to 400 K) and over six orders of magnitude of incident laser excitation power. Optically induced charge depletion (OICD) was seen in both the wetting layer (WL) and quantum dots/rings but with remarkably different temperature dependent behavior. Holes originating from background acceptors migrate out of the WL as the sample temperature is raised to 30 K, while the onset of a blueshift in the PL from quantum rings, signaling their thermally induced charging with holes, is only observed at temperatures above 300 K. The presence of dark dots as a hidden reservoir for acceptor holes at the intermediate temperatures is proposed to explain this anomalous behavior. Due to the deep localization potential of GaSb/GaAs, thermalization of acceptor holes between dark dots and bright rings only occurs above room temperature. A rate equation model is presented which successfully replicates the main features of OICD observed here and in previous reports

Keyword: Quantum dots; Quantum rings; Optically induced charge depletion; Wetting layer.