Investigation of localized electric fields of InAs/GaAs quantum dot interfaces

T. I. Kang,[1] J. S. Kim,[1] S. J. Lee[2]
[1]*Department of Physics, Yeungnam University, Gyeongsan 38541, Korea*
[2]*Division of Convergence Technology, Korea Research Institute of Standards and Science, Daejeon 34113,Kore*

In InAs/GaAs QDs, the strain-induced lattice deformation and strain induced dislocation could generate localize electric fields (LEF) due the piezo-electric fields [1]. Therefor the electric field distribution could be more complex at the interface of QDs than for the 2D superlattice (SL). The strain-induced complex electric fields can significantly modify the quantum confinement states. Direct observation of strain-related effect, such as the LEFs caused by strain-induced polarizations and defects, is therefore very important. Photoreflectance spectroscopy (PR) is useful for investigating LEFs of semiconductors [2]. In the case of GaAs, the Franz-Keldysh oscillations (FKOs) that appear above the band gap of GaAs and contain information about the LEFs in GaAs. To investigate InAs/GaAs quantum confinement states PR experimental results were reported [3]. However, experimental observation of LEFs attributed to strain between InAs QD and GaAs has not been the focus of many studies.

In this work, we investigated LEFs between InAs QD and GaAs by PR. FIG.1 shows the InAs/GaAs QDs sample used in this work. FIG. 2 shows the PR spectra of the InAs/GaAs QD samples obtained at low temperature. The low-temperature PR spectrum of the InAs/GaAs QD shows clear FKO transitions above the GaAs band gap energy. This work suggests that the interface electric fields attributed to strain originate from the strain-induced polarization near the InAs QD interface in GaAs metric. We suggested that the FKOs originated from the LEFs predominately caused by the strain-induced polarization at GaAs interface near the InAs QDs. The InAs/GaAs QDs have a broad range of interface electric fields from ~10^4 V/cm to ~2×10^5 V/cm.

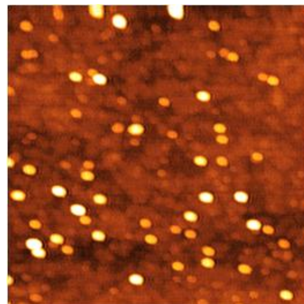

Figure 1. AFM image of InAs/GaAs QD

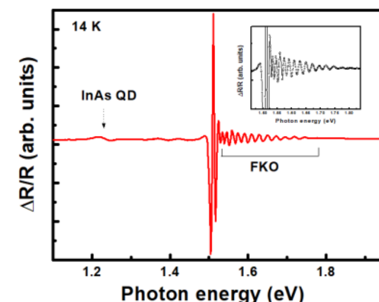

Figure 2. Low temperature PR spectrum of InAs/GaAs QD

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+ Author for correspondence: jongsukim@ynu.ac.kr