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Evidence of type-I to type-II band alignment evolution in InAsP/GaAs self-assembled quantum dots

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Abstract

In this work we studied the shape anisotropy and its relation with the band alignment in the InAsP/GaAs quantum dots by means of three technics: polarized photoluminescence, time resolved photoluminescence and magneto photoluminescence. For comparison, InAs/GaAs and InP/GaAs quantum dots were also analyzed, as not only their recombination energy sets a lower and an upper limit to the InAsP/GaAs quantum dots, but also they present different band offsets - type I and type II, respectively. Polarized photoluminescence results showed a larger in-plane shape anisotropy for the InAsP/GaAs sample with higher phosphorous contents and time resolved photoluminescence pointed towards higher time decay for this same sample in comparison with the one richer in arsenic, indicating a type I/type II transition in the alloy. Magneto photoluminescence provided additional evidence by revealing an Aharonov-Bohm type oscillation when the hole ground state changes its angular momentum from lh =0 to lh =1 and 2, which is only possible in type II heterostructures. In this way, we were able to identify a type-I to type-II progressive evolution for the band alignment of InAsP/GaAs quantum dots.