28p-A8-12 急速熱アニールによる単一量子ドット荷電子帯混合の増加

Enhancing valence band mixing in single quantum dots by rapid thermal annealing

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Quantum dots (QDs) provide an interface between flying qubits and stationary qubits, by coupling the polarization of a photon to the spins of electron and holes confined to the QD. Confinement within the QD separates the heavy and light holes, rendering the ground state mostly heavy hole-like. Under unpolarized excitation, recombination from X^+ gives rise to an unpolarized single peak. However, there is some valence band mixing (VBM; mixing between the heavy and light holes [1]); as heavy and light holes couple to the electron spin via photons with orthogonal selection rules, recombination from excitons with a light hole component leads to photons with an elliptical polarization. The *degree* of ellipticity corresponds to the *strength* of the heavy hole – light hole mixing; the *orientation* of the elliptical polarization corresponds to the *phase difference* between the heavy and light holes. Under unpolarized excitation, we excite equal amounts of elliptical polarized light of opposite helicity: accordingly, the overall polarization of the emission is partially linearly polarized.

In this work, we investigate the polarization of emission from X^+ in tens of QDs in as-grown and annealed samples. The QDs were grown the partial cap annealing (PCA method). A piece of this sample was subjected to a rapid thermal anneal at 650C. The samples were compared by means of a micro-photoluminescence setup at low temperature (10 K). By exciting with an unpolarized HeNe laser, we inject non-polarized carriers above the GaAs band edge, permitting the observation of X^+ from a QD. We completely measure the degree and direction of linear polarization finding that the average degree of linear polarization for the unannealed (annealed) sample to be about 23% (40%), almost doubling (fig. 1). Annealing causes In-Ga intermixing together with the concomitant increase in the QD size: the increase in light hole effective mass, together with the reduction of growth direction strain and confinement, possibly increases the VBM.

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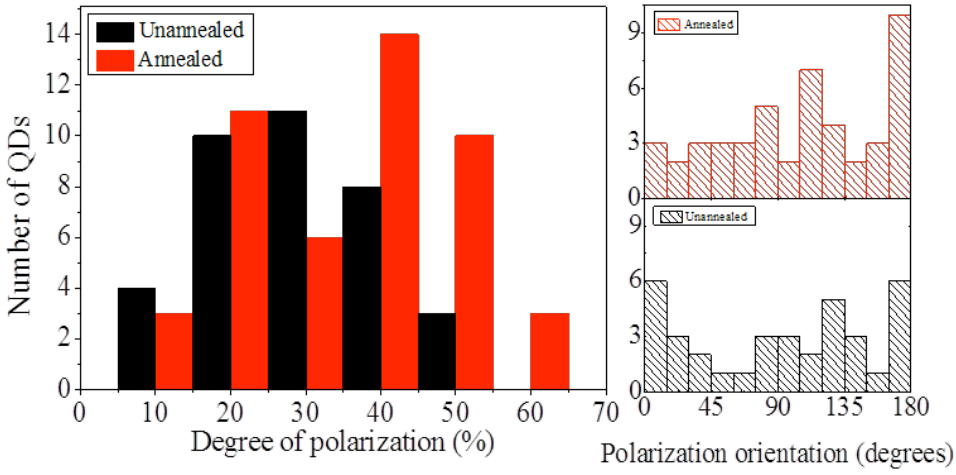

Figure 1 The degree (left) and angular distribution (right) of linear polarization for X^+ in unannealed (black) and annealed (red) sample

[1] Leger *et al.*, PRB **76** 045331 (2007), Ohno *et al.*, APL **98** 161912 (2011)