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Alloy systems such as Ga_{1-} In As consist of different random assignments σ of the Ga and In atoms onto the cation sublattice; each configuration σ having, in principle, distinct physical properties. In infinitely large bulk samples different σ's get self-averaged. However, in finite quantum dots (QDs ($\leq 10^5$ atoms , self-averaging of such configuration σ may not be complete, so single-dot spectroscopy might observe atomic-scale alloy randomness effects. We examine theoretically the effect of such atomic-scale alloy randomness on the fine structure-splitting (FSS of the multiexciton observed via the polarization anisotropy of its components. We find that (i The FSS of the neutral monoexciton ^{0} changes by more than a factor of 7 with σ. Thus, dots provide clear evidence for the effect of the atomic-scale alloy randomness on the optical properties. (ii For multiexcitons, the effect of alloy randomness can be so large that the polarization of given emission lines in samples that differ only in random realizations can be dramatically different, so it cannot be said that given transitions have fixed polarization. (iii

hole exciton has a multiplicity $2\times 2=4$. Electron-hole exchange interaction then causes splitting into $2+1+1$, where the lowest state ($2\times$ is dark denoted as transition 1 in Fig. 1(a and transitions 2 and 3 are optically active. Figure 1(b shows the calculated variation of FSS with different random realizations. Interestingly, while FSS exhibits significant dependence on the RR (from 1.1 to 8.5 μeV , it shows almost no sensitivity to piezoelectric field, irrespective of piezoelectricity was included via linear term only,[22,23] or both linear and nonlinear terms.[24,25] The polar plots in Figs. 1(c and 1(d show the polarization directions of transition 2 and transition 3 of Fig. 1(a as they vary with the RR. Remarkably, the polarization of transitions 2 and 3 can even change directions (e.g., compare polarization directions for random configurations σ_1, σ_3, and σ_4 . However, transitions 2 and 3 are , aligned along orthogonal axes. Note that the variation with the RR of the polarization directions of transitions 2 and 3 and their FSS are correlated. For example, for RR=σ_1, transition 2

The linear polarization ratio is a measure[9,12] of the in-plane polarization anisotropy, and is defined as =(− /(+ , where and are intensities, given by Eq. (1 , along 110

oms in the dot so that the variance falls below a given threshold. For example, our model dot contains $^{(dot}_{1}$ $\approx 28\,993$ atoms (

swap polarization directions with RRs. For example, transition 2 is oriented along 110 for RR= σ_1, but for RR= σ_2 along 110 .

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We have provided clear evidence for the effects of atomic-scale randomness on the optical properties of alloyed Ga_{1-} In As QDs. We find that random realizations determine monoexciton's FSS, varying more than a factor of 7 with σ, and the sign and magnitude of the linear polarization ratio. The polarization directions of multiexcitonic transitions also strongly depend on atomic-scale alloy randomness, so different multiexciton emission lines do not have fixed po-