

Controlling polarization anisotropy of excitonic emission from single quantum dots

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Single photon sources exploiting polarization degree of freedom are highly demanded for quantum information processing applications, e.g. quantum key distribution. In this context, a deterministically polarized quantum emitter based on a semiconductor platform and operating at wavelengths for long (1550 nm) and short distance (1300 nm) fiber-based quantum communication systems is strongly desired.

In this work, we investigated a polarization anisotropy of exciton emission influenced by the polarization dependent Purcell effect due to confined optical modes in the submicrometer mesa structures. We focused on the InAs/InGaAlAs/InP quantum dashes (QDashes) with known

excitonic properties [1] and its intrinsic degree of linear polarization (DOLP) of 25% resulted from the strongly asymmetric confinement potential. By using asymmetric mesa structures an additional polarization anisotropy of exciton emission has been measured (μ PL) reaching total DOLP of 60% in a broad spectral range and confirmed by numerical simulations (FDTD). Obtained agreement of the numerical and experimental results enables extension of this approach towards precise control of the total DOLP by applying more rigorous geometries. In particular, we found that a nearly linearly polarized quantum emitter, exceeding total DOLP of 90% and 95% at telecom windows of 1300 and 1550 nm, respectively, can be designed by inducing strong in-plane asymmetry of the mesa structure. Additionally, we found a nontrivial dependence along z -axis (growth direction), exhibiting strong DOLP enhancement (see Fig. 1). This example shows that in tailoring polarization anisotropy intrinsic polarization of quantum emitter, dielectric structure asymmetry and emitter position are significant factors that need to be taken into account. Furthermore, this simple treatment is related only to the geometry and in general can be applied for any quantum emitter embedded in patterned samples.

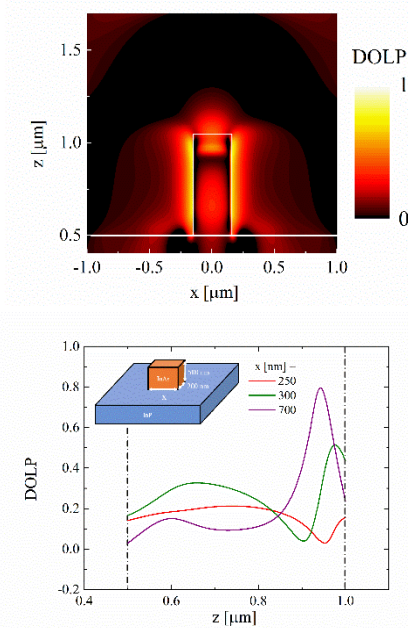


Figure 1. Cross-sectional optical DOLP distribution calculated for asymmetric mesa structure at 1.3 μ m (upper) and a nontrivial optical DOLP dependence along z -axis for different geometries (lower).