

Optical anisotropy in single InAs/InP quantum dot and quantum rod nanowires

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In recent years, an increasing interest in the use of nanowire heterostructures for light emitting applications is observed. The integration of quantum dot or quantum rod nanowires (QD-NWs or QR-NWs) in more complex photonic structures such as NW networks or hybrid NW – photonic crystal structures requires to understand and to control the orientation of the dipole in the quantum emitter. One way to investigate the dipole orientation is to perform polarization-resolved photoluminescence (PL) measurements on single NWs.

In the present work, the degree of linear polarization (DLP) is investigated for InAs QDs and QRs in wurzite InP NWs at the single NW level. In such crystalline structure, it is known that the dipole polarization is perpendicular to the [0001] direction. Measurements revealed that the emission polarization is mainly perpendicular to the [0001] NW axis for the QD-NWs but strongly parallel in the case of the QR-NWs. To explain these results, we must take into account that the measured DLP is not only due to the intrinsic DLP of the emitter. It is known that a NW of high-refractive material can screen the electric field perpendicular to the NW axis when the NW diameter becomes much smaller than the emitter wavelength. Consequently, finite difference in time domain (FDTD) calculations were performed to take into account the impact of the NW environment and then extract the intrinsic polarization of the emitter.

From this experimental and theoretical study, we have shown that the intrinsic QD-NW emission polarization is nearly 100% perpendicular to the NW axis. As far as the QR-NWs are concerned, the intrinsic polarization contains a component parallel to the NW axis. This means that, despite the heavy hole-light hole splitting in wurzite InAs, a mixing occurs between these two bands for emitters presenting a high height to diameter ratio.