Proceedings of the 5th International Conference on Nanotechnology: Fundamentals and Applications
Prague, Czech Republic, August 11-13, 2014
Keynote Lecture II

Flying Q-bits and Entangled Photons from Single Quantum Dots Enabling Quantum Cryptography

Dieter Bimberg and Andre Strittmatter
Institut für Festkörperphysik and Center of NanoPhotonics,
Technische Universität Berlin, Hardenbergstraße 36
Germany

Abstract - Efficient generation of polarized single or entangled photons is the crucial requisite for novel quantum key distribution systems and quantum information processing. Single semiconductor quantum dots are capable of emitting such photons on demand using pulsed current injection.The realization of highly efficient electrically driven single photon sources (SPS) operating at very high repetition frequencies based on well established semiconductor technology is presented. Our resonant (Q =170) single-QD diodes generate single polarized photons at a repetition rate of 1 GHz (Bimberg et al., 2009) and exhibit a second order correlation function g(2)(0) = 0. Future high yield production of SPEs demands low defect density positioning of single QDs realized by strain driven self-organisation on top of oxide apertures (Strittmatter et al., 2012; Unrau et al., 2012).

QDs grown on (111) oriented substrates of cubic semiconductors are proposed (Schliwa, 2008) and demonstrated (Schliwa et al., 2009) as source of entangled photon pairs. Intrinsic symmetry-lowering effects leading to the splitting of the exciton bright states are shown to be absent for this substrate orientation. Here biexciton to exciton recombination cascade of a QD can be directly used for the generation of entangled photons.

Complementary studies of c-plane GaN/AlN QDs (Winkelnkemper et al., 2008) reveal their potential as emitters of single or entangled photons still at high temperatures paving the way to true room temperature applications (Kindel et al., 2010).

References

D. Bimberg et al., IEEE Photonics Journal 1, 58 (2009)
A. Strittmatter et al., Appl. Phys. Lett. 100, 93111 (2012)
W. Unrau et al., Appl. Phys. Lett. 101, 211119 (2012)
A. Schliwa, M. Winkelnkemper, and D. Bimberg, PCT patent application 2008
A. Schliwa et al., Phys. Rev. B80, 161307 (2009)
M. Winkelnkemper et al., J.Phys. Condens. Matter 20, 4542111 (2008)
C. Kindel et al., Phys. Rev. B81, 241309 (2010),