Homogeneous Array of Nanowire-Embedded Quantum Light Emitters

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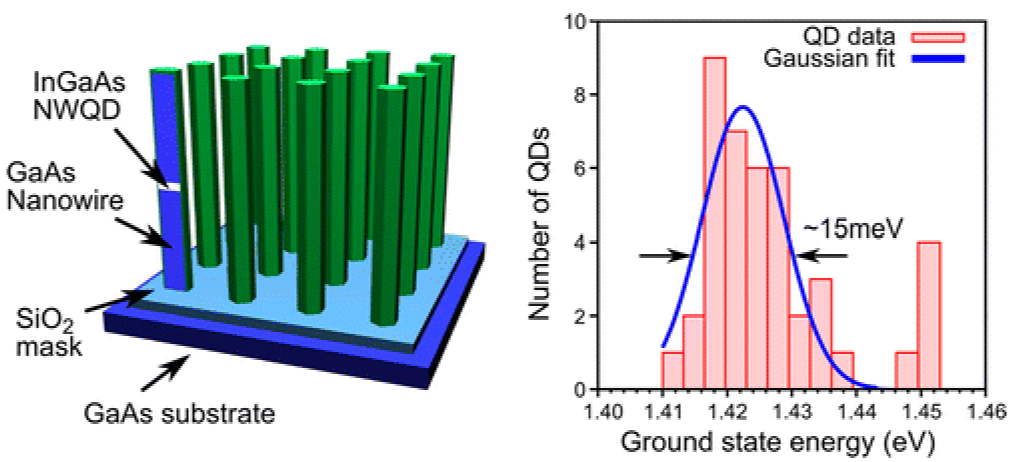
Abstract



The potential for scale-up coupled with minimized system size is likely to be a major determining factor in the realization of applicable quantum information systems. Nanofabrication technology utilizing the III–V semiconductor system provides a path to scalable quantum bit (qubit) integration and a materials platform with combined electronic/photonic functionality. Here, we address the key requirement of qubit-site and emission energy control for scale-up by demonstrating uniform arrays of III–V nanowires, where each nanowire contains a single quantum dot. Optical studies of single nanowire quantum dots reveal narrow linewidth exciton and biexciton emission and clear state-filling at higher powers. Individual nanowire quantum dots are shown to emit nonclassically with clear evidence of photon antibunching. A model is developed to explain unexpectedly large excited state separations as revealed by photoluminescence emission spectra. From measurements of more than 40 nanowire quantum dots, we find emission energies with an ensemble broadening of 15 meV. The combination of deterministic site control and the narrow distribution in ensemble emission energy results in a system readily capable of scaling for multiqubit quantum information applications.