# A Quarter-Century of Quantum Dots: From Science to Practical Implementation

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Following Esaki's pioneering work on super-lattices and quantum wells, the concept of quantum dots was proposed by Arakawa and Sakaki in 1982 for application to semiconductor lasers with the theoretical prediction of temperature insensitive threshold current characteristics. Full confinement of electrons in the quantum dots has brought up unique features of artificial atoms, such as discrete energy states and correlation effects due to spin/charging effects. This has resulted in a wide variety of experimental investigations into semiconductor physics and device applications.

Owing to recent progress in the self-assembled growth technique of high-quality quantum dots, high speed 1.3 μm quantum-dot lasers with temperature-insensitive characteristics were demonstrated by the University of Tokyo and Fujitsu. This successful achievement led to the launch of a curve-out type of venture company called QD Lasers Corporation in 2006. The quantum dot lasers will be in a real commercial market in the quite near future for telecom applications. In addition to nanophotonic device applications, single or coupled quantum dots are promising for quantum information devices, such as single photon emitters and quantum-bit devices, by manipulating single photon-electron interaction and quantum entangled states based on electron spins, charges, and nuclear spins.

In this presentation, we discuss the basic physics of the quantum dot and relevant recent advances for nanophotonics including quantum dot lasers, single artificial atom lasers and coherent light matter interaction quantum dots embedded in 2D/3D photonic crystal nanocavity. In addition, other potential applications such as bio-medical markers and solar energy technologies are described. Quantum dots are one of the most important nanostructures for the future "Green Society" which can be realized by highly efficient and low-power ubiquitous IT.