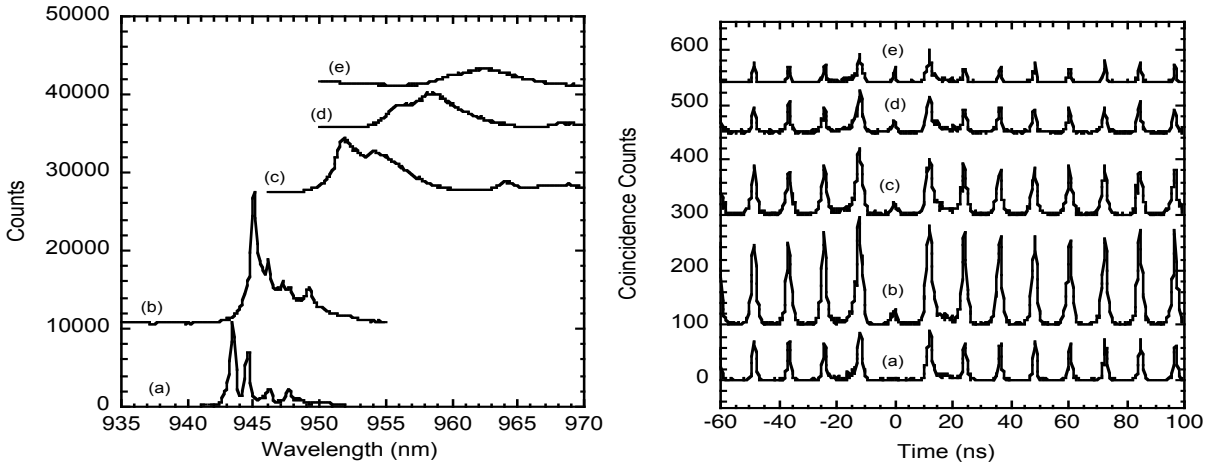
Single photon sources based on single quantum dots

Richard P. Mirin
Optoelectronics Division, National Institute of Standards and Technology, 325 Broadway, Boulder, CO 80305
Phone: (303) 497-7955; FAX: (303) 497-3387; e-mail: mirin@boulder.nist.gov

Abstract: We describe temperature-dependent photon antibunching measurements from single InGaAs/GaAs quantum dots. The second order intensity correlation demonstrates single emitter emission up to 120 K and nonclassical light emission to 135 K.

We demonstrate that an optically injected single QD can emit single photons on-demand over a wide temperature range (5-120 K). Analysis of the emission spectrum at each temperature indicates that the primary cause of the high-temperature degradation of the second order intensity correlation, $g^{(2)}(t)$, is due to the emission from charged excitons and biexcitons that spectrally overlaps the exciton emission line[1]. This degradation is exacerbated by the need to excite with high optical power in order to generate a sufficient single photon flux to obtain a good signal-to-noise ratio.

Figure 1 shows the temperature-dependent optical spectra emitted from a single InGaAs/GaAs QD excited at 850 nm by a mode-locked Ti:sapphire laser. Figure 2 shows a histogram of correlation counts as measured by a Hanbury Brown-Twiss interferometer (in the limit of low collection efficiency, which in this case is about 10^{-5}, the histogram is an accurate representation of $g^{(2)}(t)$). The value of $g^{(2)}(0)$ ranges from 0.089 at 5 K to 0.471 at 120 K. At 135 K, the value of $g^{(2)}(0)$ increases to 0.667, which still indicates nonclassical light emission that is equivalent to emission from three individual emitters.



[1] R. P. Mirin, Applied Physics Letters **84** (8), 1260 (2004).