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Silicon Nanocrystal Field Effect Light Emitting Device (FELED)
HARRY ATWATER, Caltech, ROBB WALTERS, Caltech, GEORGE BOURIANOFF, Intel — We have fabricated novel light emitting devices termed "Field Effect Light Emitting Devices" (FELEDs) incorporating silicon nanocrystals as the active optical medium. The devices consist of MOS transistors with an embedded floating gate comprised of ∼5E12 nanocrystals/cm^2 (2-4nm diameter) isolated from the channel by an ∼4nm tunnel oxide and isolated from the gate contact by an ∼8nm thick control oxide layer. The gate contact is designed to be optically transparent at the emission wavelength of the nanocrystals (∼780nm). In contrast to traditional LEDs in which charges are driven into an active region by a constant current, the charges in this device are injected sequentially into the silicon nanocrystal array from the channel of the transistor by an alternating gate potential. Excitons are thus formed only at bias transitions. Time resolved electroluminescence measurements show rise times of order 100nsec and EL decay times of ∼30μsec for abrupt changes in gate bias (+/-6 Volts). These measurements are consistent with a charge injection model based on Coulomb-field enhanced Fowler-Nordheim tunneling. We will discuss the performance of our prototype devices, which is limited by a number of non-idealities, and comment on the prospects for efficient light emission in optimized FELED structures.

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