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Tailoring Quantum Dot Assemblies to Extend Exciton Coherence Times and Improve Exciton Transport[1] KENTON SEWARD, ZHIBIN LIN, MARK LUSK, Department of Physics, Colorado School of Mines — The motion of excitons through nanostructured assemblies plays a central role in a wide range of physical phenomena including quantum computing, molecular electronics, photosynthetic processes, excitonic transistors and light emitting diodes. All of these technologies are severely handicapped, though, by quasi-particle lifetimes on the order of a nanosecond. The movement of excitons must therefore be as efficient as possible in order to move excitons meaningful distances. This is problematic for assemblies of small Si quantum dots (QDs), where excitons quickly localize and entangle with dot phonon modes. Ensuing exciton transport is then characterized by a classical random walk reduced to very short distances because of efficient recombination. We use a combination of master equation (Haken-Strobl) formalism and density functional theory to estimate the rate of decoherence in Si QD assemblies and its impact on exciton mobility. Exciton-phonon coupling and Coulomb interactions are calculated as a function of dot size, spacing and termination to minimize the rate of intra-dot phonon entanglement. This extends the time over which more efficient exciton transport, characterized by partial coherence, can be maintained.

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