**Crystallographic Structure and Photoluminescence of Atomically Ordered (Cd,Mn,Zn)Se Quantum Dots in (Mn,Zn)Se Matrix**

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Transmission electron microcopy (TEM) in both the parallel illumination and scanning probe mode revealed 3-D atomically ordered entities in molecular beam epitaxy-grown nominal (Cd,Mn,Zn)Se/(Mn,Zn)Se multi-quantum well structures. All of the larger entities possessed the following orientation relationship with the matrix: $(020)_{(Cd,Mn,Zn)Se} \parallel (\bar{2}20)_{(Mn,Zn)Se}$; $(110)_{(Cd,Mn,Zn)Se} \parallel (\bar{1}13)_{(Mn,Zn)Se}$; and $[001]_{(Cd,Mn,Zn)Se}$ parallel to $[110]_{(Mn,Zn)Se}$, whereby $\parallel$ symbolizes that both sets of reciprocal lattice vectors are parallel and of equal length. Because this is an elastic lattice mismatch strain energy-minimizing orientation relationship, we believe that these entities are low Gibbs free energy structures.

The comparison of photoluminescence spectra from a nominal $CdSe/(Mn_{0.1}Zn_{0.9})Se$ multi-quantum well structure with those of a reference structure that was grown to the same nominal specification under otherwise identical conditions, except that no Mn was incorporated into the cladding layers, revealed for the former sample two additional peaks at approximately 2 and 2.1 eV. We attribute these two photoluminescence peaks to two types of atomically ordered quantum dots with different crystallography and size. Because these peaks are at lower photo-luminescence energies than typical random alloy quantum dots of the same net chemical composition, and because the entities from which the peaks arise are low Gibbs free energy structures, atomically ordered quantum dots possess superior quantum confinement effects and improved long-term structural stability, that is, they are the better quantum dots.