The inestimable value of modelling is not lost on the scientific community. Here a team of researchers at Lehigh and Princeton University model semiconductor quantum dots, in order to establish the temperature that these devices can tolerate.

Three dimensional semiconductor quantum-dot model

A novel approach has been developed by researchers at Lehigh University and Princeton University to model semiconductor quantum dots and their high temperature interdiffusion effects in 3-D.

Semiconductor quantum-dot structures are generally thermally unstable. Both electronic and optical properties of the dot alter significantly under moderately high temperature treatment during epitaxial growth or other post growth processes.

This effect, called quantum-dot interdiffusion or quantum-dot intermixing (Figure 1), will limit the versatility of this material system to select process conditions and device applications. With our simple model, researchers will be able to predict the process temperature that can be tolerated by the quantum-dots during epitaxial growth and post growth processing to increase the manufacturing yield.

Led by Boon S. Ooi, an associate professor at Lehigh University, and assisted by Oki Gunawan (Ooi’s former master student; now a PhD student at Princeton University) and Hery S. Djie (a research scientist at Lehigh University), the first universal 3-D model for interdiffused semiconductor quantum-dots has been developed.

The analysis is published in the May 2005 issue of Physical Review B. In this model, the group applies a new approach to solve the Hamiltonian matrix in reciprocal space domain, and performs fast Fourier transform to obtain a solution in real space.

The key advantage of the model is the significant reduction of routine calculations to handle the massive and complex Hamiltonian matrix. Also, the analysis gives a natural representation of a large array of dots, and can be universally applied to all types and shapes of quantum nanostructures, including superlattice, quantum-well, quantum wires, quantum-dash, quantum-disk, and quantum-dot-in-well structures.

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