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Atomic-scale structural characterization of InAs/GaAs based quantum-dot nanostructures

Shenwei Tan, Stephen Bremner, Liping Dai and Zongwen Liu
The University of Sydney, Australia

Quantum-dot-based technology is a promising route for the realization of high-performance photovoltaic devices. The tuneability of optoelectronic properties of quantum dots makes them applicable for a range of novel device designs that offer power conversion efficiencies well in excess of conventional limits. The optoelectronic performance of the QDs, i.e. how well they absorb and emit light, is crucial to realizing these advanced concept devices. We report on InAs quantum dots whose optoelectronic performance has been improved by a Sb treatment prior to capping with GaAs. Significant increase in photoluminescence output is seen with a maximum performance for intermediate Sb spray times. The atomic structure of the Sb-sprayed QDs and the surrounding material matrix was investigated by means of high-resolution transmission electron microscopy (HRTEM) and atom probe tomography (APT). The results reveal the variability of dot shape and size, chemistry complexity and the degree of intermixing between Sb/dots and capping layer. These results can offer insights into the performance boosts observed and how further improvement might be made.

stan9986@uni.sydney.edu.au