Next Generation of Quantum Dot Devices Based on Tailored Nanostructured Materials

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By nano-structuring of semiconductors, the macroscopic material properties can be directly controlled by the geometric dimensions of the nano-objects rather than by the chemical composition. However, by using the most commonly applied Stranski-Krastanov growth mode the control of the quantum dot geometry in most cases is suffering by size fluctuations and the statistical distribution of nucleation sites.

This presentation gives an overview about our recent work on developing improved and new growth processes for quantum dot materials, exhibiting an enhanced degree of freedom for tailoring the material properties for specific optoelectronic device applications.

Improvements obtained in quantum dot growth techniques will be discussed in different quantum dot material systems (GaAs and InP based) and by using different growth techniques, like Stranski-Krastanov growth mode, droplet epitaxy and growth on pre-patterned surfaces. Device examples will be given, where this new generation of quantum dot material is used to tailor specific devices properties. This includes, e.g., 920 nm cooler-less high power pump modules based on quantum dot laser arrays with internal temperature compensation, 1060 nm high brightness single mode lasers for frequency doubling based on a tunneling injection design, and new generation of high-gain InP quantum dot material for high-speed lasers and optical amplifiers.

Finally, an outlook will be given on the potential of tailored quantum dot material to realize ultra-fast optoelectronic devices approaching the THz frequency regime.