Nanostructures and interfaces in III-V compound semiconductors

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Nanostructures such as quantum dots (QDs) and nanowires (NWs) are highly attractive in the construction of advanced optoelectronic devices, photovoltaics and sensors. By integrating the unique physical properties of III-V compound semiconductors into quantum-sized structures, a substantial enhancement of quantum confinement is anticipated, leading to high internal quantum efficiency miniature devices.
However, the heteroepitaxial growth of nanostructures on large lattice-mismatch foreign substrates stimulates interfacial phenomena that can severely influence their structural and electronic properties and thus, their optical response. Furthermore, the quantum-confinement Stark effect (QCSE), induced by the spontaneous internal piezoelectric field in polar-grown strained nanostructures, can lead to a strong charge separation. On the other hand, spatial fluctuations of the active element mole fraction within a nanostructure results in the localization of carriers, increasing the exciton radiative recombinations. Hence, a consistent realization of the strain state of nanostructures is absolutely essential.
To resolve such complicated issues, Transmission Electron Microscopy (TEM) based techniques are among the most suitable means not only to investigate their nanostructural properties, but also to determine the strain allocation along heteroepitaxial interfaces and the local chemistry of nanostructures, due to their high spatial resolution and the ability for direct observation and accurate determination of structural and crystallographic characteristics at the nanoscale.

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