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LP-MOVPE growth and properties of high Si-doped InGaAs contact layer for quantum cascade laser applications

Ściana, B.; Badura, M.; Dawidowski, W.; Bielak, K.; Radziewicz, D.; Pucicki, D.; Szyszka, A.; Żelazna, K.; Tłaczała, M.

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Abstract:

The work presents doping characteristics and properties of high Si−doped InGaAs epilayers lattice−matched to InP grown by low pressure metal−organic vapour phase epitaxy. Silane and disilane were used as dopant sources. The main task of investigations was to obtain heavily doped InGaAs epilayers suitable for usage as plasmon−confinement layers in the construction of mid−infrared InAlAs/InGaAs/InP quantum−cascade lasers (QCLs). It requires the doping concentration of $1\times10^{19}cm^{-3}$ and 1×10^{20} cm^{-3} for lasers working at 9 µm and 5 µm, respectively. The electron concentration increases linearly with the ratio of gas−phase molar fraction of the dopant to III group sources (IV/III). The highest electron concentrations suitable for InGaAs plasmon−contact layers of QCL was achieved only for disilane. We also observed a slight influence of the ratio of gas−phase molar fraction of V to III group sources (V/III) on the doping efficiency. Structural measurements using high−resolution X−ray diffraction revealed a distinct influence of the doping concentration on InGaAs composition what caused a lattice mismatch in the range of –240 ÷ –780 ppm for the samples doped by silane and disilane. It has to be taken into account during the growth of InGaAs contact layers to avoid internal stresses in QCL epitaxial structures.