Heterostructure Designs for High-power 1450 nm Lasers

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We develop AlGaInAs/InP heterostructure for pulse-pumped multimode semiconductor lasers with high pulse optical power and temperature stability. For this purpose we have grown several heterostructures and produced the lasers to compare their output characteristics under pulse-pumped (100 ns / 1 kHz) mode of operation.

Initial heterostructure No1

A typical high-power laser heterostructure design implemented for AlGaInAs/InP.

Due to the material system properties, the electrons escaped from the active region to p-waveguide can flow to the p-cladding layer. This stray current decreases the internal quantum efficiency especially at high pump current levels.

The problem:

No energy barrier for electrons at the p-side.

Heterostructure No2

The evident way of suppressing the electron escape is to place an artificial barrier layer [1]. In our works we place the barrier at the InP-AlGaInAs heterojunction.

The problem:

The barrier prevents the electron escape to the p-cladding, but increases the charge carrier accumulation in the p-waveguide.

Heterostructure No3

The barrier layer is at the waveguide-cladding heterojunction and at the same time it is close to the active region [2].

We had to decrease the total waveguide width to provide stable single transverse mode lasing.

Heterostructure No4

Heterostructure with an ultra-narrow waveguide.

We achieved the highest power and temperature stability for the heterostructures with an ultra-narrow waveguide and demonstrated that the doping profile is extremely important for this design. The obtained results can be useful for high-power pulse laser systems required for automotive LIDARS and other ranging finders applications.