Simulation of high-power semiconductor lasers at sub-zero temperatures

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GaAs–based broad–area diode lasers deliver the highest optical output power P_{out} with the highest power conversion efficiency η_{c} from electrical to optical power of any light source. However, continuous increases in both P_{out} and η_{c} are necessary for improved performance and reduced cost (in \$/W) in current laser systems and to enable new applications. Increases in performance are particularly important for high energy class diode pumped solid state laser systems such as those in planning for application in inertial confinement fusion. Research studies have shown that a reduction of the heat sink temperature below zero leads to an increase of P_{out} and η_{c} [1], [2].

Recently, we investigated the factors limiting the output power of broad–area diode lasers operated at room temperature (300 K) using the device simulation program 'WIAS-TeSCA' [3], [4]. We here present a comparative study of P_{out} and η_{c} of lasers operated at room temperature and at a sub-zero temperature (200 K). We will discuss the temperature dependencies of several parameters entering the simulation. We will also present an analysis of the factors responsible for the improvement of the laser performance when going from 300 K to 200 K. Finally, a comparison with experimental results will be made.

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References

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