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Title:Superconducting microdisk cavities for THz quantum cascade lasers

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Abstract:We present superconducting waveguides for terahertz (THz) quantum cascade lasers (QCLs). Double-metal waveguides provide high confinement of the optical mode and low waveguide losses which are dominated by absorption of the radiation in the metal layers. Implementing novel waveguide materials like superconductors is one way to reduce these losses. In order to prove the compatibility with the THz QCL active region and waveguide we have replaced the commonly used gold or copper layers by superconducting niobium (Nb). We have simulated the temperature distribution inside the THz QCL in order to evaluate the operation conditions at which the critical temperature of the Nb layers is not exceeded. Experimental results of THz QCLs with Nb waveguides are presented which show lasing emission despite the fact that the energy of the THz radiation of the investigated active region f= 2.5THz= 10.3meV is higher than the superconducting energy gap of Nb 2 Δ = 2.8meV. Calculations show that improvements in terms of lower waveguide losses can be achieved using a superconductor with higher critical temperature and thus wider superconducting gap e.g., NbTiN or MgBinf2/inf. © 2011-2012 IEEE.

Number of references:21

Main heading:Superconductivity

Controlled terms:Electric losses - Lasers - Microcavities - Niobium - Quantum cascade lasers - Superconducting materials - Temperature - Waveguides

Uncontrolled terms:Active regions - Copper layer - Critical temperatures - Double-metal waveguide - High confinement - Lasing emissions - Metal layer - Microdisk cavities - Niobium

(Nb) - Operation conditions - Optical modes - quantum-cascade - Superconducting energy gap - Superconducting gaps - Terahertz - THz quantum cascade lasers - THz radiation - Waveguide loss - Waveguide materials

Classification code:744.1 Lasers, General - 714.3 Waveguides - 714 Electronic Components and Tubes - 708.3 Superconducting Materials - 701.1 Electricity: Basic Concepts and Phenomena - 641.1 Thermodynamics - 549.3 Nonferrous Metals and Alloys excluding Alkali and Alkaline Earth Metals

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