Terahertz optically pumped silicon lasers

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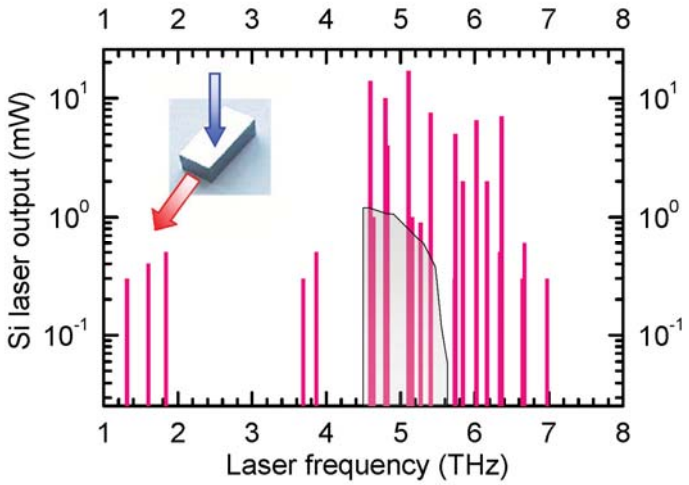
Stimulated terahertz (THz) emission from silicon single crystals doped by group-V donors has been obtained by optical excitation with pulsed infrared lasers. Pumping by a conventional TEA CO_2 laser results in lasing on discrete lines between 1.3 and 7 THz (see figure). Laser thresholds can be as low as 10 kW/cm^2. They depend on the donors species and the laser mechanism. Intracentre population inversion is realized between particular excited states which are large-spaced due to the chemical shift of the donor binding energy. The lifetime of an electron in an excited state (up to ~70 ps) is determined by the efficiency of phonon-assisted nonradiative relaxation. Optical excitation by the emission of a frequency-tunable free electron laser results in two different types of lasing. At relatively low pump intensities (~1 kW/cm^2) the intracentre mechanism of lasing is dominating. At pump intensities above ~100 kW/cm^2 stimulated scattering of pump photons on transverse acoustic intervalley phonons can occur in the vicinity of an impurity atom. This results in laser emission in the frequency range from 4.6 to 5.8 THz. In this case the laser frequency can be tuned proportionally to the pump frequency (solid area in figure).



Emission spectra of THz silicon lasers. Discrete lines correspond to intracentre laser transitions. The grey area shows the region where continuously frequency-tunable emission is obtained.