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标题: Quantum cascade laser: a compact, low cost, solid-state source for plasma diagnostics
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摘要: Quantum cascade lasers (QCL) are unipolar injection lasers based on intersubband transitions in a modular semiconductor heterostructure. The first THz QCL, operating at 67 mu m (4.3 THz), was demonstrated in 2002; the wavelength range now extends beyond 250 mu m (1.2 THz) and is entering the sub-terahertz frequency range for devices operated in external magnetic field. Although a number of different quantum designs have been demonstrated, increasing the operating temperature remains a major challenge: the maximum temperature is still similar to 195 K, and recently approached 225 K in high magnetic fields. Nevertheless, compact continuous wave systems operating within Sterling coolers already ensure ample portability and turn-key operation and QCLs represent then the THz solid-state radiation source that actually shows the best performance in terms of optical output power, which can reach more than 100 mW average, and linewidth, typically in the tens of kHz for single mode devices. THz QCLs have then a realistic chance to deeply impact technological applications such as process monitoring, security controls, and bio-medical diagnostics. They are ideally suited though for plasma polarimetry and interferometry, thanks to their high polarization selectivity, excellent stability and ruggedness, and ease of high-speed modulation. Their compact size and monolithic cavity arrangement allows placement in the very proximity of the plasma to be monitored, easing requirements of stability against vibrations etc. Furthermore, the long coherence lengths should be easily compatible with interferometric arms of even very different lengths, a geometry ideal for coupling to a plasma reactor. The possibility of direct current modulation at MHz if not GHz frequencies ensures then an excellent temporal resolution of the meaurements, and a large low-frequency noise rejection. New analysis schemes also become feasible, for instance employing two-color lasers, operating at the same time at two appropriately chosen wavelengths, or exploiting the laser emission tunability for implementing frequency modulation techniques. This paper will discuss the current state-of-the-art in THz QCL technology and applications, focusing on those aspects of greatest relevance for plasma diagnostics.
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