Progress in Semiconductor Reference Oscillator Development for Coherent Detection Optical Remote Sensing

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Abstract

High power 2.05-micron Fabry-Perot and distributed feedback (DFB) ridge waveguide lasers fabricated from epitaxially grown InGaAsSb/AlGaAsSb/GaSb and InGaAs/InP hetero-structures are reported. This work is part of a NASA Earth Science Enterprise Advanced Technology Initiatives Program research effort to develop semiconductor laser reference oscillators for optical remote sensing from Earth orbit. Specifically, local oscillators provide the frequency reference required for active spaceborne optical remote sensing concepts that use heterodyne (coherent) detection. The two most prominent Earth observation applications for this technology are Doppler lidar wind sensing and tropospheric carbon dioxide measurement by laser absorption spectrometry, the currently favored operational wavelength for both of which is 2.05 microns. Frequency-agile local oscillator (FALO) technology is critical in such applications because of the need to compensate for large platform-induced Doppler components that would otherwise compromise data reduction and interpretation. The semiconductor laser-based FALO option offers considerable scope for reduced mechanical complexity and improved frequency agility over equivalent crystal laser devices, while their potentially faster tuning ability holds significant potential for enhanced scanning versatility. Typical uniform DFB semiconductor lasers at the wavelength of interest here exhibit unacceptable linewidth broadening at the high currents and output powers required for operation in an optical heterodyne receiver. Suppression of gain nonlinearities inside the laser cavity that lead to linewidth broadening is achieved by means of corrugation pitch-modulated (CPM) DFB grating structures. CPM-DFB lasers utilize a grating segment of slightly different pitch to achieve added uniform light intensity along the laser cavity. Initial CPM-DFB ridge waveguide lasers have been fabricated from InGaAs/InGaAs/InP material operating at a wavelength of 1.55 microns preparatory to extension of the same approach to similar material grown for the target 2.05-micron wavelength.

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