Simulation about the semiconductor double wavelength external cavity Laser for the generation of tunable terahertz waves with compact structure

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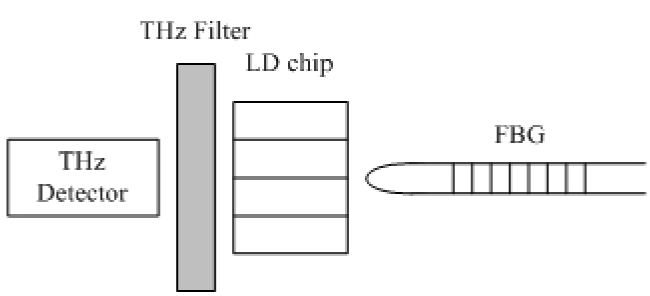
***Abstract*—A semiconductor double wavelength external cavity Laser for the generation of tunable terahertz waves with compact structure is proposed and simulated. The difference frequency effect in the gain medium itself of the laser cavity is used to produce THz electromagnetic waves directly. The simulation results show that the proposed external cavity double wavelength laser is one of the good candidates to realize compact and tunable THz generation.**

SUMARRY: Many optical methods about THz generation have been proposed since the advantage of their wide tunable range over all other technologies. The basic physical principles of all these proposed optical methods can be classified into optical parametric processes, optical differential frequency effects and excitation of photoconductive materials with ultrashort optical pulses[1-5]. Despite a lot of progress in recent years, many of the THz source are still very complexity and the whole structure is still very large since the complexity of the pumping laser. On the other hand, compact sources of THz radiation have many important industrial, medical, scientific and security applications [1-2]. Terahertz generation by difference frequency methods has many advantages such as no threshold value, simple device, and compact structure. In this paper, a semiconductor double wavelength external cavity Laser for the generation of tunable terahertz waves with compact structure is proposed and simulated. The double-wavelength semiconductor external cavity laser is realized by the semiconductor laser diode with antireflection coat followed by a FBG which has two reflecting central wavelengths. The difference frequency effect in the gain medium itself of the laser cavity is used to produce THz electromagnetic waves directly.

The principle scheme for the simulation is shown in Fig.1.



The one end of the quantum-well laser is coated with an antireflection film. The other coated end is assumed to be transparent to the Terahertz wave but has high reflection to the lasing wavelength. The lasing wavelength of the external cavity laser is determined by the center-wavelength of the fiber grating. When the resonant cavity of the external laser is operated at steady state, two lasing mode will be feedback by the fiber Bragg gratings, and will produce a stable oscillation of two mode. The frequency of the generate terahertz is just determined by the difference frequency of the two lasing modes. Moreover, the center-wavelength of the fiber Bragg grating can be changed by the adjustment of the period of the Bragg Fiber Gratings. Thus the oscillation wavelengths can be changed. As a result, the frequency of the generate terahertz is tunable. In the entire design, we do not use any individual nonlinear crystal to generate the terahertz wave; instead, we use the nonlinear effect of gain medium in the semiconductor laser to produce terahertz directly.

The analysis of the entire system can be divided into two parts, i.e., the generation of double-wavelength by external cavity semiconductor lasers and the generation of terahertz by nonlinear frequency mixing.

The behavior of semiconductor laser can be described by the rate equations. Here, we use the double-mode rate equations to simulate the lasing process of the proposed external cavity laser diode. On the other hand, the generation of THz wave can be simulated using the coupled wave equations for the description of the optical mixing in the nonlinear crystal. The simulation results can be used to prove that the proposed external cavity double wavelength laser is one of the good candidates to realize compact and tunable THz generation.

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