We report on both theoretical study and simulation of the terahertz (THz) electromagnetic pulse excitation during intense laser interaction with solid targets. Several mechanisms of THz broadband wave generation are proposed. Conversion efficiencies of laser radiation into THz electromagnetic pulse for these mechanisms have been compared. Surface and volumetric THz waves generated from different targets have been considered.

1. Introduction

Terahertz (THz) electromagnetic radiation has useful features for a number of applications such as diagnostic, scanning, security and communications. An intense laser-solid target interaction is promising and poorly investigated THz radiation source which may leads to high energy conversion efficiency from laser to THz pulse $\sim 10^{-3}$ [1] and to high pulse energy. It has no any thresholds for energy of initial laser pulse which means that no energy limits for a resulting THz pulse. Several mechanisms of generation of the THz pulses, e.g. radiation generation during sheath acceleration process at the target rear surface [2] or THz emission by electrical current of fast electrons escaping a target [3] have been proposed. We report theoretical and numerical comparison of three different mechanisms of THz radiation generation from the laser plasma sources [4,5].

2. Results

The theory of THz radiation generated due to escape of hot electrons, plasma expansion into vacuum [4] and thermo current [5] is developed. Contributions of different laser-induced electron currents to the volumetric and surface THz pulses have been found. It has been shown that energy conversion efficiency from laser to volumetric THz radiation may reach $10^{-9}$ for escaping high-energy electrons. The near-surface thermolectric mechanism and plasma expansion into a vacuum are less effective for THz generation. Theoretical study of transition radiation from hot electrons generated in the laser–solid interaction Phys. Plasmas, 10, p2994,(2003)

References