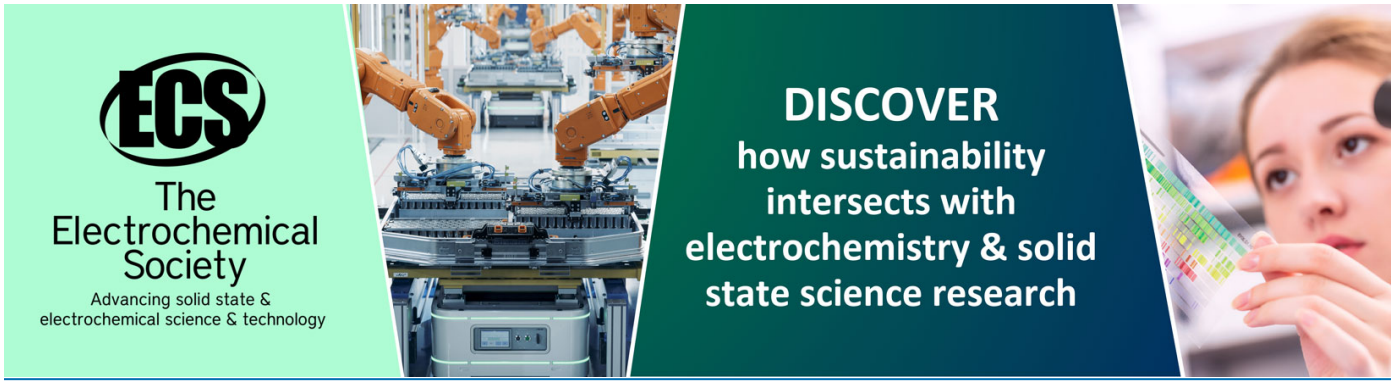
Effective modulation of the terahertz radiation force



Effective modulation of the terahertz radiation force

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Synopsis The radiation force of the terahertz field is realized and highly modulated by changing the spatial distribution of the THz field, which is controlled by the coupling effects of the laser field, external magnetic field, and self-generated plasma channel. Moreover, the stability of the terahertz radiation is also discussed.

Teraherta (THz) radiation has attracted much attentions for a variety of promising applications [1]. At present, the optical force are ideally studied to realize the optical trapping and manipulation of single cells [2]. In particular, the trapping and manipulation technology based on the infrared light has significantly less optical damage to a variety of living cells with more better biocompatibility [3]. But the realization of the teraherta radiation force (TRF) is still an undeveloped issue. That's, to develop the THz technology applications in optical trapping and manipulation, high performance modulators and active filters to control and manipulate the THz waves are in high demand. Unfortunately, many technology for controlling the THz wave strongly rely on the expensive THz transmitted system and the pump lights.

In this paper, we present an efficient method to control the intensity of the electric field, the spatial structure and the radiation force of the THz field with an external magnetic field, which is confirmed by the two dimensional particle-in-cell (PIC) simulations [Fig. 1]. When the magnetic field equal to zero, the twin-peak structure of the THz field is symmetry about the y = 0 axis [Fig. 1 (a) and (b)]. When the intensity of the magnetic field increases, the symmetry of the twin-peak structure (the intensity and the width of the each peak) will be controlled [Fig. 1 (a) and (b)]. Note that, the twin-peak structure of the THz field can generate the four-peak structure of TRF ($\mathbf{F}_{TRF} \propto \nabla E_{THz}^2$) which results in the formation of the double quasi-stable trapping region [I and II region of the Fig. 1 (c)]. Interestingly, the double quasi-stable trapping region can be modulated, and even be broken by changing the structure of the THz field with the strong magnetic field [Fig. 1 (d)]. In our scheme, the instabilities of the terahertz radiation is discussed in the strong laser field ($a \geq 4$) and super-strong magnetic field ($B \geq 60T$) [Fig. 1 (e) and (f)].

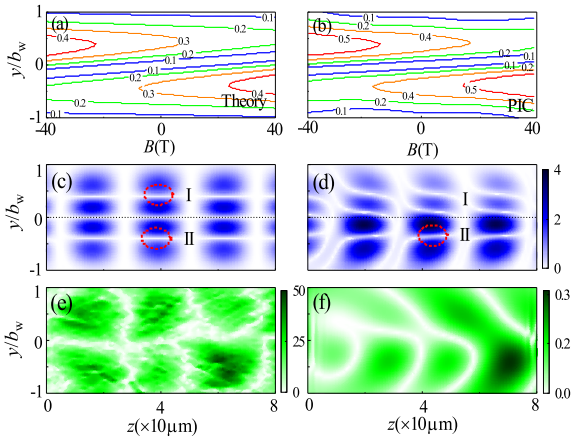

Figure 1. (color online) Variation of E_{THz} (MV/cm, the first row) against the transverse coordinate and the intensity of the magnetic field. The F_{TRF} (the second row) across the transverse coordinate and the longitudinal coordinate. The instabilities phenomenon of E_{THz} with the strong laser field (e) and super-strong magnetic field (f).

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References

[1] Zhang Z 2018 *Nat. Photonics* **12** 554
[2] Wang L G *et al* 2013 *Optics Express* **19** 15
[3] Ashkin A *et al* 1987 *Nature (London)* **330** 769

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