Enhancement of terahertz radiation with circularly polarized two-color fields

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***Abstract* – We demonstrate an enhancement of terahertz wave generation from plasma produced by circularly polarized two-color fields when the laser intensity is high enough to saturately ionize the gas. Comparing to the linear two-color fields, the conversion efficiency of co-rotating circularly polarized two color-fields is about 40% higher.**

I. INTRODUCTION

In recent years, the electric fields of terahertz radiation has been increasing up to kV/cm-MV/cm [1]. Specially, terahertz wave generated from laser induced plasma has become more attractive due to its broad bandwidth and high peak-power [2]. In the previous two-color scheme, the fundamental and its second-harmonic fields are always linear polarized, so that the synthesized electric field is asymmetric and can break the symmetry of ionization significantly to deliver extremely intense terahertz. The relative phase between the two-color fields is a key factor to the pump-to-THz conversion efficiency and thus needs to be carefully optimized. However, terahertz generation from plasma induced by circularly polarized laser pulses was proposed as a way to control the polarization of terahertz in early studies [3]. Here, we show that terahertz generation with circularly polarized two-color fields will result in higher conversion efficiency.

II. EXPERIMENT SETUP

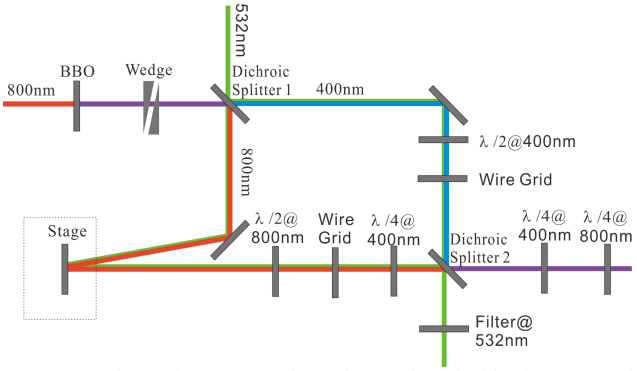

Fig. 1. Experimental setup. BBO is used to produce double- frequency. The wedge pairs are applied to control the relative phase. The combination of half-wave plates and wire grid is used to adjust the intensity and polarization of two pumps. Three quarter-wave plate are employed to produce the circular pumps.

Our experimental setup is shown in Fig. 1. A Mach-Zehnder interferometer configuration is employed so that the fundamental laser pulses, which are centered at 800 nm with 100 fs pulse duration delivered by a Ti:sapphire chirped pulse amplification system, are separated with their second harmonics. Then wave plates and wire grid polarizers are used to change the polarization from linear to circular for 800 nm and 400 nm pulses, respectively. The two-color circular polarized pulses are combined and focused onto the air gas target to generate terahertz radiation. The delay between the two-color fields can be finely tuned with a pair of wedges with a motorized stage. The path difference of the two arms of the Mach-Zehnder interferometer is stabilized by sending a continuous laser pulse (532 nm) through the interferometer and monitoring the interference fringes.

III. RESULTS AND DISCUSSION

The intensity of the generated terahertz radiation is detected by an integrating thermal detector (Golay cell). In the experiment, several possible combinations between linearly or circularly polarized fundamental laser pulses and linearly or circularly polarized second-harmonics were tested. For linear polarization laser pulses, terahertz radiation will be more intense if the two fields are parallel rather than orthogonal. And the counter-rotating two-color fields will result in less intense terahertz radiation comparing to co-rotating circularly polarized pulses. Fig. 2 shows the comparison of terahertz intensity generated by two-color fields with parallel linear polarization and co-rotating circular polarization, and the result indicates that the conversion efficiency of co-rotating circularly polarized two color-fields is about 40% higher than the linear pulses.

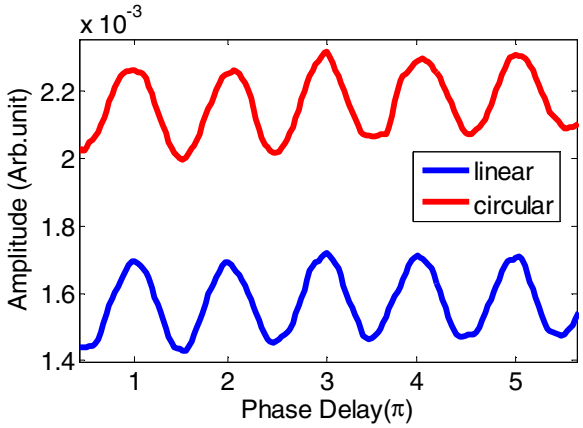

Fig. 2 the terahertz yields generated from two-colors with different polarization.

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