PARAMETRIC STUDIES OF TWO-COLOR ULTRAFAST TERAHERTZ GENERATION IN GAS PLASMA FILAMENTS*

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Previous studies have demonstrated the preponderance of intense ultrafast terahertz (THz) sources based on two-color gas plasma filaments with extremely broad bandwidths in excess of 70 THz[1]. Applications ranging from nonlinear THz materials science to broadband hyperspectral detection drive the need for such sources to be optimized for output power and spectral content. Further, it would also be useful to have a source with a sufficiently high repetition rate frequency for sensitive lock-in coherent detection methods. Previous studies have also relied on THz field detection where propagation of the pulse through ambient conditions which are known to be deleterious to the pulse fidelity through water vapor absorption, and in turn, affects spectral fidelity. It is desirable, from the perspective of practical THz sources for spectroscopy, that these sources and their associated generation mechanisms be studied for optimal generation with peak THz fields in the MV/cm range. For instance, understanding spectral content, total energy in pulse, optimal gas concentration, focusing conditions, inter-pulse phase slippage, and tunability are all parameters for consideration that affect output in these sources.

In our presentation we report on strong THz pulse generation in a variety of gases (air, Ne, Ar, Kr, and Xe) using our two-color ultrafast pulse generation method[1,2]. We concentrate on kilohertz-based ultrafast generation techniques with attention to THz time domain based interferometric power spectral measurements as the gas species, pressure, and laser pulse energy are varied. We find that we can routinely produce THz pulses as short as 40 fs, μJ-level pulse energies, and having a frequency spectral bandwidth of more than 40 THz. A simple 1-D fluid model based on Maxwell's equations describing THz generation via field ionization resulting in an asymmetric transverse plasma current in the driving optical two-color field is used to simulate the results for comparison with experiment.

1. K. Y. Kim, K.Y. Kim, J.H. Glownia, A.J. Taylor, and G. Rodriguez, "Coherent control of terahertz supercontinuum generation in ultrafast laser-gas interactions," Nat. Photonics **2**, pp. 605-609 (2008).
2. K.Y. Kim, J.H. Glownia, A.J. Taylor, and G. Rodriguez, "Terahertz emisssion from ultrafast ionizing air in symmetry-broken laser fields," Opt. Express **15**, pp. 4577-4584 (2007).

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