Efficient generation of ultrashort high-order anti-Stokes pulses in the DUV-VUV region by four-wave Raman mixing using BOXCARS configuration in hydrogen gas.

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Ultrashort optical pulses in the deep-ultraviolet (DUV) and vacuum-ultraviolet (VUV) regions are useful due to their relatively high photon energies[1]. Application of photon ionization in gas chromatography and mass spectrometry (GC-MS) technique has been proved to be a sensitive analytical method[2]. In order to generate ultrafast laser pulses in these spectral regions, four-wave Raman mixing (FWRM) in a gas was expected to be a useful method under collinear three-color pump beam configuration. In fact, anti-Stoke Raman sidebands up to 185 nm have been generated[3]. In this study, we generated ultrashort laser pulses in the DUV and VUV regions using four-wave Raman mixing in hydrogen gas under non-collinear configuration, i.e. a BOXCARS configuration. A spatial filtering can be successfully used for isolation of a specific emission line for applications.

The fundamental beam of a Ti:sapphire laser (800 nm, 35 fs, 3.6 mJ, 1 kHz) was used as a pump beam. The Stoke pulse emitting at a wavelength of 1200 nm was generated by passing the fundamental beam through an optical parametric amplifier (OPA). The third harmonic emission of the fundamental beam at 267 nm was employed as a probe pulse. After being overlapped in time, three pulses were focused into a hydrogen-filled gas cell under the BOXCARS configuration. The experimental was presented in the figure 1(a).

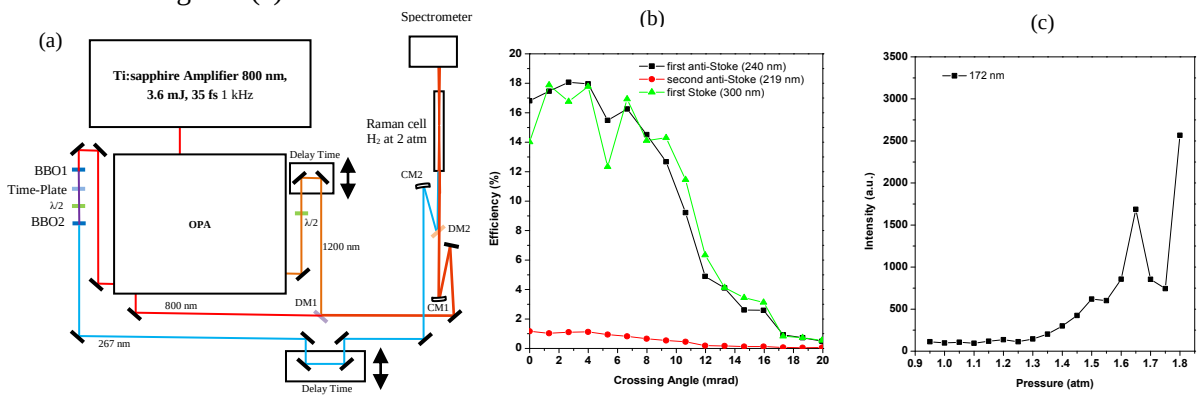

Figure 1: (a) The experimental setup: BBO 1-2, β-BBO crystal; CM 1-2, concave mirror; DM 1-2, dichroic mirror; λ/2, half-wave plate. (b) Efficiency of FWRM on the crossing angle. c) The intensity of the fifth-order anti-Stoke at different H_2 pressure.

The highest efficiency was observed at 1.8 atm, while the optimum crossing angle between pump and probe pulses was about 2.67 mrad. At the best condition, the conversion efficiency from the probe beam to the first anti-Stoke beam (240 nm) was 18 % (figure 1(b)). The anti-Stoke sideband was observed up to the fifth order, i.e. at 172 nm (figure 1(c)).

References

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