Efficient generation of 11-eV pulses in Kr and Xe using a turnkey Yb:KGW laser

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Ytterbium-based laser sources are in steady growth in recent years. With the advantage of a compact, higher average power, and higher repetition features compared with traditional Ti:sapphire lasers, they can potentially be used for ultrafast spectroscopy in vacuum- and extreme ultraviolet regions with higher photon flux [1]. In particular, the femtosecond pulses in the vacuum ultraviolet (VUV, ~11 eV) are useful for angle-resolved photoemission spectroscopy (ARPES) of solids because of their relatively high photon energy and the ease of achieving ultrahigh vacuum conditions by using transmissive LiF or MgF_2 windows.

We have developed a high-repetition-rate (50 kHz) 11-eV beamline based on the THG in Krypton and Xenon gases of the third harmonic of Yb;KGW laser at 343 nm. The 1030-nm, 280-fs drive pulse goes through a commercial 3rd harmonic conversion setup, which is then focused by a CaF_2 lens (f=250 mm) into a gas-filled chamber with a typical pressure range of 5 to 15 kPa (Fig.1). The generated 11-eV beam is separated from the 343-nm beam by two dichroic mirrors and characterized by a phototube or a grating-based spectrometer with an X-ray CCD. The beam divergence is estimated to be 9 mrad and can be tuned to a desirable level with an iris cropping the pump beam.

The conversion efficiency in Kr is estimated to be as high as 1.5×10^{-4} at the optimum pressure of 8.7 kPa (Fig. 2), which are comparable with previously reported cases [2]. As 11 eV pulses up to 1 nJ can be generated at a maximum repetition rate of 50 kHz, this setup is sufficient for time-resolved ARPES. The high single pulse energy also has a potential for nonlinear spectroscopy in the VUV region.

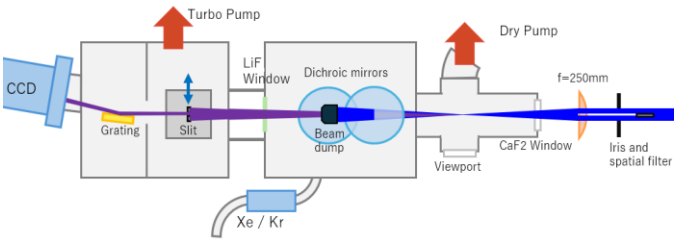

Fig. 1. Spectroscopy and generation setup.

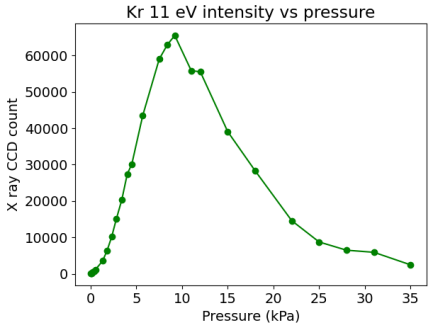

Fig. 2. Pressure dependence of VUV yields with Kr.

References

[1] E. Lorek *et al.* Rev. Sci. Instruments **85**, 123106 (2014).

[2] Z. Zhao and Y. Kobayashi, Opt. Express **25**, 13517 (2017).