13:30, 02-July-2019
G201-KPSI, Kyoto, JAPAN
The 63rd KPSI Seminar, QST

High harmonic generation in solids and the driving by plasmonic enhanced field

Kotaro Imasaka, Ph.D. student
Institute of Industrial Science, The University of Tokyo
4-6-1 Komaba, Meguro-ku, Tokyo 153-8505 Japan
e-mail: imasaka@iis.u-tokyo.ac.jp

Abstract:

High harmonic generation (HHG) in solids under the strong-field regime may be induced by few-cycle optical electric-field exceeding 1 V/nm [1]. The mechanism is described as inter-band (Zener) tunnelling, acceleration of crystal electrons/holes, and the following high harmonic (HH) radiation via intra-band current and/or inter-band polarization. Because solids have high atomic density, crystal symmetry, and characteristic band structures, HHG in solids is expected to have great potential for efficient EUV attosecond sources, all-optical band-structure reconstruction, probing electron dynamics, and to develop condensed-phase attosecond science and light-wave electronics.

A smart way to obtain intense optical field for driving the strong-field phenomena is to confine electromagnetic fields by using nanostructures. Recently, Au-coated sapphire nano-cone, ZnO nano-cone, and silicon (E_g = 1.2 eV) with metallic nanoantennas have been utilized to generate odd-order harmonic radiations. Here, we demonstrate HHG into DUV range (222 nm) from ZnO (E_g = 3.4 eV) with resonant Au nanoantennas, driven by mid-infrared (MIR) femtosecond pulses [2]. Even-order as well as odd-order harmonics are observed, when the nanoantennas are oriented along the symmetry-broken crystal axis. Our results indicate that the spectral selection rule precisely reflects the crystal symmetry and that Au nanoantenna enhances HHG in solids with preserving the freedom of polarization, temporal waveform, information of electron in solids, and so on.

[1] S. Ghimire, A. D. DiChiara, E. Sistrunk, P. Agostini, L. F. DiMauro, and D. A. Reis**,** "Observation of high-order harmonic generation in a bulk crystal," Nature Physics **7**, 138 (2011).

[2] K. Imasaka, T. Kaji, T. Shimura, and S. Ashihara, "Antenna-enhanced high harmonic generation in a wide-bandgap semiconductor ZnO," Opt. Exp. **26,** 21364 (2018).