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Intense ultrashort-pulse sources for materials science

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Since the first demonstration of attosecond EUV pulse generation in 2001, attosecond science has made significant progress. In the first decade, attosecond science aimed to demonstrate proof-of-principle experiments to establish novel concepts and technique. However, its capability was limited in EUV and gas-phase targets. Such limitations were originated from Ti:sapphire laser-based technologies that indeed supported the attosecond science in its early stage. Meanwhile, recent progress of attosecond science, especially soft-X-ray high harmonic generation and high harmonic generation in solids, are supported by optical parametric amplifiers (OPAs) or optical parametric chirped pulse amplifiers (OPCPAs) that can generate carrier-envelope phase (CEP)-stable intense pulses in the IR and MIR regions. Compared with conventional high-peak-power lasers such as Ti:sapphire chirped pulse amplifiers, the OPAs (or OPCPAs) allow us to design gain wavelength and bandwidth. The high single-pass gain is also possible, which is suited for CEP preservation during the amplification process. Negligible thermal load is advantageous to realize few-cycle intense light sources with high repetition rates when pumped by high-average-power solid state lasers. All these features are crucial to transform attosecond science to practical optical tools for materials science.

In my talk, I will overview our R&D activities on the OPA/OPCPA-based IR and MIR sources [1-4] and their applications to attosecond soft-X-ray spectroscopy [5, 6] and high harmonic generation in solids [6, 7]. I will also introduce our recent efforts in the MEXT Q-LEAP project that aims to lead materials science by combining intense ultrashort-pulse laser technology with state-of-the-art measurement technology.

References

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