Real Time Observation of the Ultrafast Dynamics Induced by XFEL Pulses in CH_2I_2 Molecule

T. Takanashi*, H. Fukuzawa*,†, K. Motomura*, K. Nagaya†,‡, S. Wada†,§, Y. Kumagai*, D. Iablonskyi*, S. Mondal*, Y. Ito*, T. Tachibana*, S. Yamada*, Y. Sakakibara*, D. You*, T. Nishiyama‡, K. Matsunami‡, T. Sakai‡, K. Asa‡, Y. Sato‡, T. Umemoto§, K. Kariyazono§, Y. Takahashi¶, M. Kanno¶, K. Nakamura¶, K. Yamazaki, S. Kajimoto¶, H. Sotome¶, E. Kukk††, K. Kooser††, C. Nicolas‡‡, C. Miron‡‡,§§, M. Schöffler¶¶, G. Kastirke¶¶, P. Johnsson***, T. Asavei§§, L. Neagu§§, X.–J. Liu†††, S. Molodtsov‡‡‡, T. Togashi§§§, K. Ogawa†, S. Owada†, T. Katayama§§§, K. Tono§§§, M. Yabashi†, A. Rudenko¶¶¶, H. Fukumura¶, M. Yao‡, H. Kono¶ and K. Ueda*,† [1]**

* Institute of Multidisciplinary Research for Advanced Materials, Tohoku University, Sendai 980-8577, Japan
† RIKEN SPring-8 Center, Sayo, Hyogo 679-5148, Japan
‡ Department of Physics, Kyoto University, Kyoto 606-8502, Japan
§ Department of Physical Science, Hiroshima University, Higashi-Hiroshima 739-8526, Japan
¶ Department of Chemistry, Tohoku University, Sendai 980-8578, Japan
** Department of Chemistry, Faculty of Science, Hokkaido University, Sapporo 060-0810, Japan
†† Department of Physics and Astronomy, University of Turku, Turku FI-20014, Finland
‡‡ Synchrotron SOLEIL, L'Orme des Merisiers, Saint-Aubin, BP 48, Gif-sur-Yvette Cedex FR-91192, France
§§ Extreme Light Infrastructure - Nuclear Physics (ELI-NP), "Horia Hulubei" National Institute for Physics and Nuclear Engineering, 30 Reactorului Street, RO-077125 Măgurele, Jud. Ilfov, Romania
¶¶ Institut für Kernphysik, J. W. Goethe Universität, Max-von-Laue-Str. 1, Frankfurt D-60438, Germany
*** Department of Physics, Lund University, Lund SE-22100, Sweden
††† School of Physics and Nuclear Energy Engineering, Beihang University, Beijing 100191, People's Republic of China
‡‡‡ European XFEL GmbH, Holzkoppel 4, Schenefeld D-22869, Germany
§§§ Japan Synchrotron Radiation Research Institute (JASRI), Sayo, Hyogo 679-5198, Japan
¶¶¶ J. R. Macdonald Laboratory, Department of Physics, Kansas State University, Manhattan, Kansas 66506, USA

Synopsis We performed time-resolved ion yield measurements for diiodomethane (CH_2I_2) molecules using a 5.5-keV intense X-ray free-electron laser (XFEL) pulse generated by SACLA as a pump, and an 800-nm near infrared (NIR) laser pulse as a probe. The molecule is multiply ionized via photoionization and Auger cascades, and then explodes due to Coulomb repulsion. Measuring the fragment ion yields as a function of the NIR pulse arrival delay, we tried to decipher the interplay between the electron and molecular dynamics induced by the XFEL exposure.

X-ray free-electron lasers (XFELs) opened the way to the investigation of unexplored dynamics and optical phenomena in the x-ray spectral region. At SACLA, in Japan, we have initiated a program to study the interaction of XFEL pulses with isolated molecules containing heavy atoms, such as iodine [1-3].

In this study, we performed time-resolved ion yield measurements for diiodomethane (CH_2I_2) molecules using a 5.5-keV intense XFEL pulse generated by SACLA as a pump, and an 800-nm NIR laser pulse as a probe. Multiple ionization occurs via cycles of 2*p* inner-shell photoionization of the iodine atom and subsequent Auger cascades, and the molecule further explodes violently due to Coulomb repulsive forces. We measured the ion yields as a function of the NIR laser arrival delay.

The resulting partial ion yields for each fragment show different temporal structures. On this basis, we succeeded in extracting information on the dynamics associated with the electronic decay processes from the experimental data and we proposed a modeling. Thus, we characterized the interplay between electron and molecular dynamics induced by the interaction with the XFEL radiation.

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References

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[1] E-mail: ueda@tagen.tohoku.ac.jp