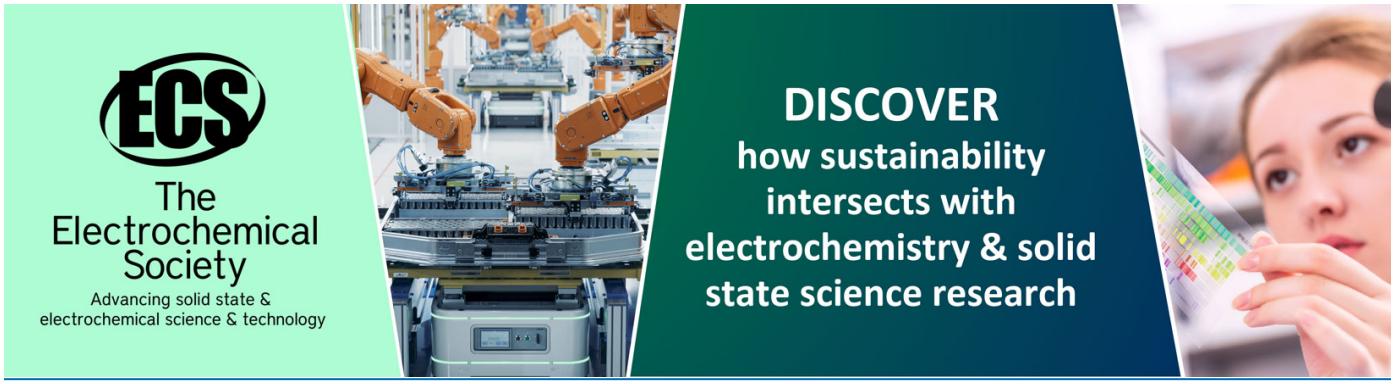
Cascade and direct processes in multiple Auger decay of core-excited states of N_2



Cascade and direct processes in multiple Auger decay of core-excited states of N_2

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Synopsis We report here a detailed experimental study on multiple Auger decay after core excitation into the π^* valence and Rydberg orbitals in N_2 by an electron-electron coincidence technique.

Relaxations of core-hole states by emission of several electrons are known as multiple Auger transitions. They are specially interesting in molecules because their dynamics involve interplay between electronic and nuclear motions, as demonstrated in CO by Kaneyasu et al [1]. They remain however little studied because efficient coincidence techniques are required. In the present study, electrons emitted after core excitation of N_2 were energy-analyzed and detected in coincidence to obtain electron-energy correlations for understanding detailed dynamics of multiple Auger decay in molecules.

The experiments were performed at the soft X-ray undulator beamline BL-16A of the Photon Factory, KEK. In order to obtain longer time interval between the light pulses, we used a mechanical chopper of which rotation synchronizes with the RF signal of the synchrotron ring and a repetition rate of 146 kHz was obtained [2]. Electrons emitted by photoabsorption were collected by an inhomogeneous magnetic field, energy-analyzed by a 2.5 m long TOF tube and detected in coincidence by a time-to-digital converter.

Figure 1 represents the energy correlations between the two electrons in the resonant double Auger processes after the 1s $\rightarrow \pi^*$ core excitation at 401.08 eV in N_2. The kinetic energies of fast electron, KE_{fast}, were converted to the binding energies of singly charged states by subtracting them from the photon energy, i.e. $h\nu - KE_{fast}$. The bottom and left panels in figure 1 are the projections on each axis. The peaks in the kinetic energy spectrum of slow electrons on the left are attributed to electrons emitted in autoionizations of superexcited neutral nitrogen atoms which are produced in cascade double Auger processes: N_2^* $\rightarrow N_2^{+*} + e^-_{fast}$ followed by $N_2^{+*} \rightarrow N^* + N^+$ and then by $N^* \rightarrow N^+ + e^-_{slow}$. The island structures on the energy correlation indicate that the intermediate singly charged states for the cascade double Auger processes lie at around 60 eV, which is formed by a spectator Auger transition.

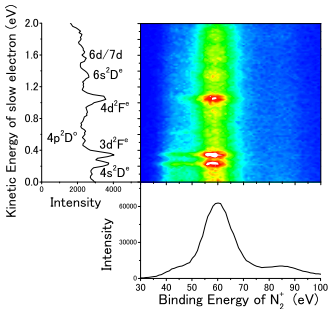

Figure 1. Energy correlations between two electrons in the resonant double Auger processes and projections on each axis (bottom and left) at 1s $\rightarrow$ π^* core excitation in N_2 (see text for details).

References

[1] Kaneyasu T 2008 *Phys. Rev. Lett.* **101** 183003
[2] Kaneyasu T 2017 *J. Chem. Phys.* **147** 104304

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