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Multi-Electron Coincidence Study on Auger Decay from Ne 1s Photoionization Satellites

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Introduction

The removal of a core electron may be accompanied by the promotion of a valence electron to a vacant orbital. The photoionization satellite states will proceed by characteristic Auger decays and then produce specific multiply-charged ion states, because the decays reflect their outer electron configurations differing from the main core-hole states. The investigation of the decay processes of the satellite states has been very limited so far, because the cross sections for the formation of the satellite states are unfavorable and the corresponding Auger events are easily hidden behind the events associated with ordinary core-hole photoionization.

In this work we have investigated the Auger decay of Ne 1s photoionization satellite states. We have used a magnetic bottle type electron spectrometer whose powerful capability in electron coincidence observations has recently been described [1,2]. The coincidence dataset includes complete information on the energy correlations among the multi-electrons emitted, from which we have deduced the Auger decay mechanism from the 1s photoelectron satellite states.

Results and Discussion

A multi-electron coincidence dataset was accumulated for Ne at the excess energy of 77.8 eV above the Ne 1s ionization threshold at 870.09 eV. Fig. 1(a) shows a photoelectron spectrum, where the energy range is arranged to show the photoelectron peaks for the formations of the Ne^+ $1s^{-1}$ state and the satellite states. The photoionization satellite states, Ne^+ $1s^{-1}2p^{-1}(^{1,3}P)np$, are resolved only partially in Fig. 1(a) with the instrumental resolution of about 1 eV. Fig. 1(b) displays coincidences between the photoelectron lines from Fig. 1(a) and slow electrons in the 0-30 eV kinetic energy range. On the two-dimensional map a striking difference can be seen between the slow electron distributions in coincidences with the Ne^+ $1s^{-1}$ and satellite photoelectrons. The slow electron distribution in coincidence with the 1s photoelectrons shows a monotonic decrease with increasing slow-electron energy. The slow electrons in coincidence with the 1s photoelectrons are slower Auger electrons in the direct double Auger decay from the Ne^+ $1s^{-1}$ state. In contrast, knots of enhancements are observed in the 0-25 eV range for the slow electron distributions measured in coincidence with the satellite photoelectrons. The structured slow electron distributions indicate that the satellites undergo Auger decay processes differing markedly from the Ne^+ $1s^{-1}$ decay.

The first Auger decay from the Ne^+ $1s^{-1}2p^{-1}np$ satellite states does not yield such slow electrons in the 0-25 eV range, because no Ne^{2+} state is expected in the ionization range lying 0-25eV below the Ne^+ $1s^{-1}2p^{-1}np$ states. Therefore, these slow electrons with discrete energies result from the subsequent decay of states created by the first Auger decay. In practice, we observe the first Auger electrons in the triple coincidence events including the satellite photoelectrons and the slow electrons. Based on the energy correlations between the two Auger electrons, we have assigned the intermediate Ne^{2+} and final Ne^{3+} states [3].

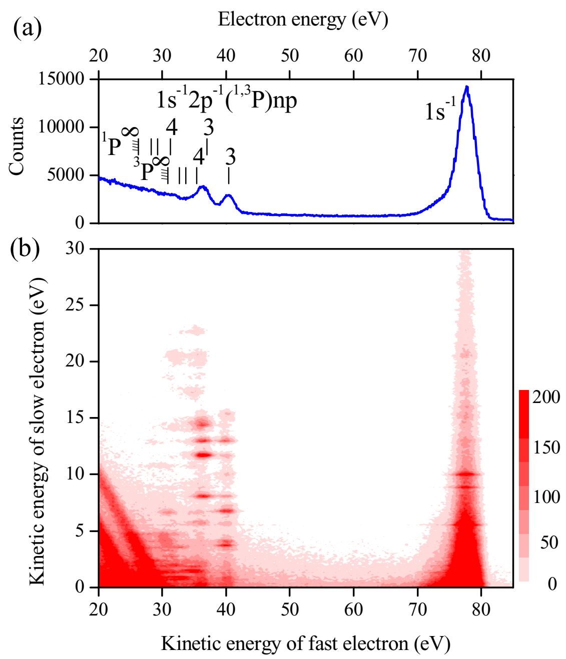

Fig. 1 (a) Inner-shell photoelectron spectrum of Ne measured at a photon energy of 947.9 eV. (b) Two dimensional map of all coincidence yields, represented as a function of the kinetic energies of fast and slow electrons. Coincidence counts are plotted on a linear scale.

References

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