

Photoionization of low-charged silicon ions

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Synopsis Single and multiple photoionization of Si^{1+} , Si^{2+} , and Si^{3+} ions have been investigated near the silicon K-edge using the PIPE setup at beamline P04 of the synchrotron light source PETRA III operated by DESY in Hamburg, Germany. Pronounced resonance structures are observed for all ions which are associated with excitation or ionization of a K -shell electron. The experimental cross sections are compared with results from theoretical calculations.

Since silicon is one of the most abundant heavy elements in the Universe, the detailed study of the electronic structure of the silicon atom and silicon ions in various charge states is of fundamental astrophysical interest. Single and multiple photoionization of Si^{q+} ($q = 1, 2, 3$) ions have been experimentally investigated in the photon energy range 1830 eV to 2100 eV. The measurements were carried out at the PIPE setup [1] at beamline P04 of the third generation synchrotron light source PETRA III at DESY (Hamburg, Germany) employing the photon-ion merged-beams technique [2]. This facility enables us to record excitation functions and to determine absolute photoionization as well as photoexcitation cross sections. Several reaction channels were investigated. Distinct resonance structures are observed for all ions. The strongest resonances are associated with the photoexcitation of a $1s$ electron to an atomic np subshell ($n=3,4,5,\dots$) and the final ionic charge states are created by subsequent multiple autoionization of the associated $1s$ hole. As an example, figure 1 shows the measured cross sections for triple photoionization of Si^{2+} ions. Resonances with principal quantum numbers n ranging from 3 to 5 can be clearly seen. Furthermore the experimental cross sections are compared with theoretical values obtained from multiconfiguration Dirac-Fock calculations (MCDF). This theoretical description takes into account the initial excitation or ionization and the subse-

quent cascade of Auger processes.

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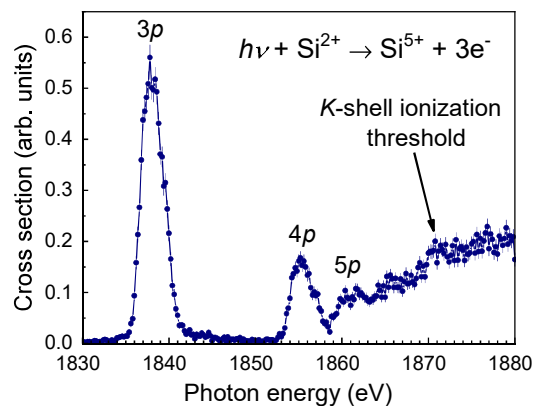


Figure 1. Experimental cross sections for triple photoionization of Si^{2+} ions as a function of the photon energy. Resonances are labelled by the np subshell to where the $1s$ electron is excited.

References

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