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Comparative study of positron- and electron stimulated ion desorption from a TiO_2 (110) surface

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When low energy positrons impinge on solid targets, they rapidly thermalize and diffuse in the bulk. Some of them reach the surface and annihilate predominantly with valence electrons. A small fraction of those positrons, however, may annihilate with core electrons, and in this case two or more electrons leave from the valence orbitals via an Auger decay process [1]. Thus, the fragmentation and desorption of ionic species from the surface may be caused by a Coulomb repulsion between the valence holes. While the bombardment of high energy positrons, as well as high energy electrons, can also lead to ion desorption via an impact excitation process, positron annihilation is the only possible desorption process for slow positrons with an incident energy below the desorption threshold by impact excitation.

Recently, we observed positron-stimulated ion desorption from a TiO_2(110) surface [2-4]. Desorbed O^+ ions were clearly detected employing a modified time-of-flight (TOF) technique even in the incident positron energy range below the desorption threshold for electron impact [2], which corresponds to the ionization energy of Ti(3p) core electrons [5]. This result provided the evidence that core-hole creation by positron annihilation with inner-shell electrons leads to the O^+ ion desorption.

In the present work, we have compared the positron- and electron-stimulated ion desorption. Considerable differences were found in the desorbed ion species and TOF distributions. Moreover, the desorption yield of the O^+ ions for positron-stimulated desorption is one order of magnitude higher than that for electron-stimulated desorption. These results suggest that the positron surface states and the annihilation-site selectivity strongly affect the desorption process.

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