§22. Secondary Electron Emission Yields from TiO_2 under Low-Energy Singly and Doubly Charged Ion Impact

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It is well known that the secondary electron emissions (SEE) from solid surfaces under ion impact are separated in two parts: one is the potential emission (PE) and the other the kinetic emission (KE). The purpose of the present study is to investigate the SEE from clean non-metallic surfaces at low incident energies (< 0.5 keV) where the PE becomes dominant, because investigations of non-metallic surfaces are quite few. In the present study, TiO_2 was used as a non-metallic target.

A compact duo-plasmatron ion source provided low energies (≦ 2.5 keV) ions. After charge and mass selection by a Wien filter, the ions were bent by 90 degrees and directed into a collision chamber. Before arriving at the target surfaces, the incident ion beam was decelerated through a series of the retarding electrodes. The present set-up consists of two chambers: the preparation chamber (1×10^{-10} Torr) and the main chamber (5×10^{-11} Torr). The target surfaces were cleaned by the sputtering of argon ions. The surface cleanness was examined by an Auger-electron-spectrometer (AES). Finally the targets were brought onto the beam line normal to the incident ion beam. The current of the secondary electrons was measured with stainless-steel double-cylindrical-cups [1].

Incident ions used in the present study were H^+, He^+, Ne^+, Ar^+, Ar^{2+}, Kr^+, Kr^{2+}, Xe^+ and Xe^{2+}. The results for Ar^+ are shown in Fig.1. We find the followings. For ions with the potential energies smaller than 20 eV, H^+, Ar^+, Kr^+, Xe^+, the SEE decreases with decreasing the ion energy. On the other hand, for ions with the potential energy larger than 20 eV, the SEE approaches the constant value. These constant values are regarded as the PE yields. In table 1, the present experimental results of the PE yields are summarized.

The KE yields are deduced by subtracting the PE yields from "total" SEE yields. It appears that the KE yields for singly and doubly charged ions lie on a single curve, indicating that the KE yields are independent of the incident ion charge. It also appears that the KE yields are roughly proportional to the ion energy for < 2.5 keV.

To estimate the SEE due to the potential energy of the incident ions as a function of parameters relevant to the solid, some studies have been made for metallic targets [2-4]. According to these studies, the PE yields are proportional to the potential energy of the incident ions. However, the present results are found to be not the case(see table 1). As one of the reason, we need to check the effects of metastable ions in the incident beams, because the electronic structure of the incident ion is extremely important. In order to estimate the ratio of metastable ion in the incident beam, measurements of photons due to deexcitation of metastable ions are in progress.

Table 1. The experimental results for the PE from TiO_2. The PE has not been observed for H^+, Ar^+, Kr^+ and Xe^+ ions.

ion	potential energy (eV)	PE yield
H^+	13.60	---
He^+	24.59	0.095
Ne^+	21.57	0.072
Ar^+	15.76	---
Ar^{2+}	43.38	0.22
Kr^+	14.00	---
Kr^{2+}	38.56	0.14
Xe^+	12.13	---
Xe^{2+}	33.34	0.077

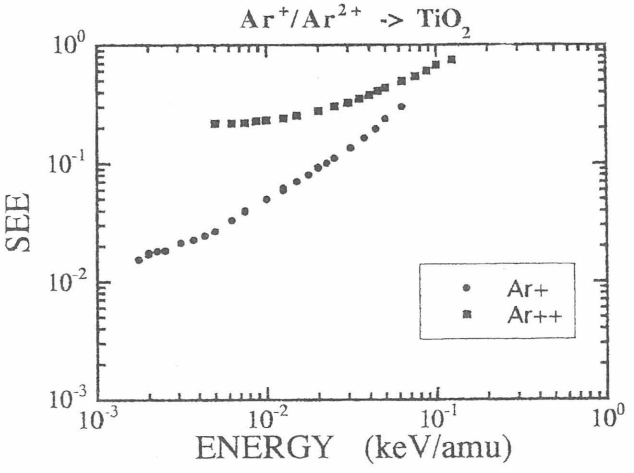

Figure 1. Impact energy dependence of the SEE under Ar^+ and Ar^{2+} ion impact on clean TiO_2 surface.

References

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