

Positron-annihilation-induced Auger electron spectroscopy studies of the (100) and (111) surfaces of silicon

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Abstract

Experimental results are presented which provide a direct comparison of spectra obtained using positron annihilation induced Auger electron spectroscopy (PAES) for two different faces of a semiconductor, Si(100)-(2 × 1) and Si(111)-(7 × 7), taken under similar experimental conditions. The factors that affect positron annihilation induced core-hole creation probabilities are discussed and the relationships between parameters that determine the positron annihilation induced Auger intensity and the core-hole annihilation probability by a surface-trapped positron are derived. The experimental annihilation probabilities for Si 2p core-level electrons are found to be significantly different for two studied surfaces: 2.01 ± 0.02 % and 0.65 ± 0.01 % for the Si(100) and Si(111) surfaces, respectively. The large dependence of the core annihilation rate on the crystal face differs significantly from the much smaller face dependence found on metal surfaces. The values of the annihilation probabilities for the two different silicon surfaces provide data for a stringent test of calculations of annihilation characteristics of positrons in surface states. The observed sensitivity of the annihilation probabilities to the crystal face indicates that PAES could serve as an important surface diagnostic tool capable of distinguishing different semiconductor surfaces and defining their state of reconstruction.
