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Studies of positrons trapped at quantum-dot like particles embedded in metal surfaces

Fazleev N., Nadesalingam M., Weiss A.

Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

Experimental studies of the positron annihilation induced Auger electron (PAES) spectra from the Fe-Cu alloy surfaces with quantum-dot like Cu nanoparticles embedded in Fe show that the PAES signal from Cu increase rapidly as the concentration of Cu is enhanced by vacuum annealing. These measurements indicate that almost 75% of positrons that annihilate with core electrons due so with Cu even though the surface concentration of Cu as measured by EAES is only 6%. This result suggests that positrons become localized at sites at the surface containing high concentration of Cu atoms before annihilation. These experimental results are investigated theoretically by performing calculations of the "image-potential" positron surface states and annihilation characteristics of the surface trapped positrons with relevant Fe and Cu core-level electrons for the clean Fe(100) and Cu(100) surfaces and for the Fe(100) surface with quantum-dot like Cu nanoparticles embedded in the top atomic layers of the host substrate. Estimates of the positron binding energy and positron annihilation characteristics reveal their strong sensitivity to the nanoparticle coverage. Computed core annihilation probabilities are compared with experimental ones estimated from the measured Auger peak intensities. The observed behavior of the Fe and Cu PAES signal intensities is explained by theoretical calculations as being due to trapping of positrons in the regions of Cu nanoparticles embedded in the top atomic layers of Fe. © 2009 American Institute of Physics.

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Keywords

Annihilation, Metal, Nanoparticle, Positron, Quantum dot, Surface, Trapping