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High resolution core-level photoemission spectroscopy study of the clean and the Au-nanowires-decorated Si(5 5 12) surfaces

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We have testified the structural models of the clean Si(5 5 12)-2x1 surface by using Si 2p surface core-level spectroscopy. Furthermore we have studied the evolution of Au nanowires as a function of a temperature on the Si(5 5 12)-2x1 surface from low energy-electron diffraction, Si 2p, and Au 4f core-level spectoscopy. Structural models previously proposed are differently composed of the same building blocks, i.e., a dimer, an adatom, a π-bonded chain, and a tetramer, to generate the huge 2x1 unit cell. The proper combination of the building blocks in the 2x1 unit cell was estimated from Si 2p components with lower binding energies of -0.40eV and -0.62 eV compared with bulk one. The intensities of the Si components were largely reduced after the formation of Au double wires at 400 oC and Au coverage of 0.2 ML, which implies Au adsorbates interact dominantly with Si atoms generating the two Si 2p components. At annealing temperature above 500 oC, the semiconducting Au double wires were found to begin changing into metallic nanowires in company with the formation of (332)x2 facets. In this transition, Au 4f core-level spectra showed noticeable variation while Si 2p core-level spectra kept alike. This implies the Au-Si bond nature on the (337)x2 facets deviates from one on the planar Si(5 5 12)-2x1 surface.