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Selective Band Engineering of an Isolated Subnanometer Wire

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Band engineering of a nanowire is related to the question what is the minimum size of a nanowire-based device. At the subnanometer scale, there has been a long standing problem whether it is possible to both control an energy band of an isolated nanowire by a dopant and measure it using angle-resolved photoemission spectroscopy (ARPES). This is because an extra atom in the subnanometer wire plays as a defect rather than a dopant and it is challenging to assemble isolated subnanometer wires into an array for an ARPES measurement. We demonstrate that only one of multiple metallic subnanometer wires canbe controlled electronically by a dopant maintaining the whole metallic bands of other wires, which was observed directly by ARPES. Here,the multiple metallic subnanometer wires were produced on a stepped Si(111) surface by a self-assembly method. The selective band engineering proves that the selectively-controlled metallic wire is nearly isolated electronically from other metallic wires and an electronic structure controlcan be realized down to subnanometer scale.

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