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Enhanced tunneling across nanometer-scale semiconductor interfaces[1]

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A Schottky diode is one of the simplest semiconductor devices, which makes it a suitable test-case to study the performance of a nanometer- scale semiconductor-device. Experimental systems range from an STM tip pressed onto a semiconductor substrate to semiconductor nanowires in contact with a metal. All show deviations from bulk behavior which is usually attributed to a lowered Schottky barrier. We have investigated systematically the transport properties of nanometer-scale metal-semiconductor contacts, formed by self-assembled epitaxial CoSi2-islands on Si, contacted by an STM. Our measurements indicate that tunneling plays an increasingly important role for smaller devices due to a size effect in the Schottky barrier. For metal-semiconductor contacts with a diameter smaller than the Debye length, the barrier thickness decreases with the contact size. This leads to an increase in tunneling current which explains the measured transport properties without the need to assume a Schottky barrier height deviating from the bulk value. Discreteness of doping atoms can no longer be neglected and its influence on the transport properties has been investigated both experimentally and theoretically. Statistical analysis of the conductance shows that the electronic properties of small diodes are dominated by a single dopant atom close to the metal-semiconductor interface, causing local barrier lowering even at room temperature.

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