In Situ Resistivity of Endotaxial FeSi$_2$ Nanowires on Si(110)

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We present in situ Ultra-High Vacuum (UHV) measurements of the resistivity $\rho$ of self-assembled endotaxial FeSi$_2$ nanowires (NWs) on Si(110) using a variable-spacing two-point method with a moveable Scanning Tunneling Microscope (STM) tip and fixed contact pad. The resistivity at room temperature was found to be nearly constant down to NW width $W = 4$ nm, but rose sharply to nearly double the bulk value at $W = 3$nm. These data are not well-fit by a simple Fuch-Sondheimer model for boundary scattering, suggesting that other factors, possibly quantum effects, may be significant at the smallest dimensions. For a NW width of 4 nm, partial oxidation increased $\rho$ by approximately 50%, while cooling from 300K to 150K decreased $\rho$ by approximately 10%. The relative insensitivity of $\rho$ to NW size or oxidation or cooling is attributed to a high concentration of vacancies in the FeSi$_2$ structure, with a correspondingly short length for inelastic electron scattering, which obscures boundary scattering except in the smallest NWs. It is remarkable that the vacancy concentration persists in very small structures.