Investigation of size effects in the electrical resistivity of single electrochemically fabricated gold nanowires

Karim S, Ensinger W, Cornelius TW, Neumann R
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Single gold nanowires with diameters ranging between 80 and 300 nm were fabricated by electrochemical deposition in single-pore membranes. The wires were contacted by means of a macroscopic planar electrode on each membrane side. The resistance-versus-diameter behavior was measured and is discussed considering finite-size effects, i.e., additional electron scattering both at the wire surface and at grain boundaries. Resistance-versus-temperature curves display characteristics like a bulk metal that shows a linear behavior down to about 70 K and finally approaches a limited value below 40–50 K with a residual resistivity ratio $\rho_{300\,K}/\rho_{20\,K}\approx 2.5$. The temperature-dependent resistivity data of wires with diameters larger than 200 nm fit well with the model of Mayadas and Shatzkes for grain-boundary scattering, thus confirming that surface scattering is negligible in this range.