

Influence of the Tunneling Properties of Metal-Insulator-Metal Junction on Shot-Noise Thermometry

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We measured the temperature dependence of the current-voltage characteristic and the bias-dependent shot noise of the metal(Al)-insulator(AlO_x)-metal(Al) tunnel junctions from 4.2 K to room temperature. We extracted the temperature of the junction from the shot noise data. In this presentation, we compared measurements in two cases whose shot noise characteristics were quite different; we measured an as-fabricated tunnel junction (case 1) and then measured the same junction when its characteristic has changed after several measurement and thermal cycle (case 2). For the case 1, the temperature obtained from the shot noise data agreed well with the nominal temperature of the device (which was measured with a commercial temperature sensor), but for the case 2, the inferred temperature was always higher than the nominal temperature. The conductance of the device also showed different behaviors; the conductance in the case 1 increased as bias voltage increases, but in contrast, that of case 2 decreased at high bias voltage. These phenomena in the case 2 could be explained by introducing inelastic tunneling through the barrier, which we assume comes from defects in the tunnel barrier. We suggest a model how the junction imperfection causes errors in shot noise thermometry.

Keywords: tunnel junction, thermometry, shot noise, inelastic tunneling