A good understanding of the electronic conduction processes through nanocontacts is a crucial step toward the near-future implementation of functional nanoelectronic devices. Previously [1, 2], by using two complementary contact methods, we studied the zero-bias conductances $G(T)$ and the current-voltage ($I$-$V$) characteristics of nanocontacts formed between single metallic nanowires and contacting electrodes in a wide temperature range $T = 1$–$300$ K. We found that the electronic conduction processes through these nanocontacts can be well described by the thermally fluctuation-induced tunneling conduction (FITC) theory [3] which considers the crossover feature from thermal activation conduction at high $T$ to simple elastic tunneling conduction at low $T$.

Here [4, 5], in a series of micrometer-sized metal-insulator-metal planar tunnel junctions fabricated by the electron-beam lithography technique, we have found that the FITC features also reveal in high-$G$ junctions, which implicitly manifest transport processes through short nanoconstrictions [6]. This observation of the FITC process at the micrometer scale reflects the existence of large junction-barrier interfacial roughness in the thin insulating oxide layer, where electron tunneling occurs at the sharp points of the closest approaches of the top and bottom electrodes. The formation of a few nanoscale hot spots, but not pinholes, predominantly governs the junction $G(T)$ behavior as well as its $I$-$V$ characteristics.