Electrical Characterization of Schottky Barrier between Gold and Unintentionally Doped Silicon Nanowire

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Traditional value of Schottky barrier between gold and silicon is established on large and clean surface area condition [1]. As we step into nanoscale range, the effect of the fringe electrical field as well as surface states becomes important in the sense that they may cause the fluctuation of the value of Schottky barrier.[2]

We are here to present our current experimental results of the I-V characteristic of unintentionally doped silicon nanowires (NWs) grown on the n+ substrate with gold as catalyst. This experiment is performed by using atomic force microscopy (AFM) in contact mode. The diamond tip is placed directly on top of the NW and in contact with gold catalyst to form one electrode, while the second electrode is established by ohmic contact between heavily n type doped substrate with back metal contact. In order to make sure that the current is indeed passing through NWs, measurements on the same size of gold dot island deposited on the substrate with same doping density are conduct.

The large variation of the diodic I-V characteristics of silicon NW is observed. In contrast, the variation of I-V curves obtained from gold dot catalyst is rather small. In addition, some silicon NWs show very large leakage current. From I-V log scale plot, we can see there are three distinctive regions for diode formed by gold dot and silicon substrate, namely (1) recombination current in space charge region dominates at low biased voltage (2) diffusion current in quasi-neutral region (3) high-level injection. Yet, we do not see such behavior on Si NWs.

All of the experimental results indicate that the Schottky barrier indeed varies as the size of contact area shrink into nano scale. And unintentionally doped silicon NW in our study can carry high current density with low resistivity.

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