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Superconductivity on Nb/Si(111) System : scanning tunneling microscopy and spectroscopy study

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Superconducting proximity effects of Nb/Si(111) were investigated with scanning tunneling microscopy(STM) and scanning tunneling spectroscopy(STS). A highly-doped(0.002 Ω◇cm) Si wafer pieces were used as substrate and Nb source was thermally evaporated onto the atomically clean silicon substrate. The temperature of the silicon sample was held at 600℃ during the niobium deposition. And the sample was annealed at 600℃ for 30 minutes additionally. Volmer-Weber growth mode is preferred in Nb/Si(111) at the sample temperature of 600℃. With proper temperature and annealing time, we can obtain Nb islands of lateral size larger than Nb coherence length(~38nm). And outside of the islands, bare Si(7X7) reconstructed surface is exposed due to the Volmer-Weber Growth mode. STS measurement at 5.6K showed that Nb island have BCS-like superconducting gap of about 2mV around the Fermi level and the critical temperature is calculated to be as low as 6.1K, which is lower than that of bulk niobium, 9.5K. This reduced value of superconducting energy gap indicates suppression of superconductivity in nanostructures. Moreover, the superconducting state is extended out of the Nb island, over to bare Si surface, due to the superconducting proximity effect. Spatially-resolved scanning tunneling spectroscopy(SR-STS) data taken over the inside and outside of the niobium island shows gradually reduced superconducting gap.