Magnetoresistance of Bi Nanowires Grown by On-Film Formation of Nanowires for In-situ Self-assembled Interconnection

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Semimetallic bismuth (Bi) has been extensively investigated over the last decade since it exhibits very intriguing transport properties due to their highly anisotropic Fermi surface, low carrier concentration, long carrier mean free path *l*, and small effective carrier mass m*. In particular, the great interest in Bi nanowires lies in the development of nanowire fabrication methods and the opportunity for exploring novel low-dimensional phenomena as well as practical application such as thermoelectricity[1]. In this work, we introduce a self-assembled interconnection of nanostructures produced by an on-film formation of nanowires (OFF–-ON) method in order to form a highly ohmic Bi nanobridge.

A Bi thin film was first deposited on a thermally oxidized Si (100) substrate at a rate of 40 Å/s by radio frequency (RF) sputtering at 300 K. The sputter system was kept in an ultra high vacuum (UHV) of 10^{-6} Torr before deposition, and sputtering was performed under an Ar gas pressure of 2m Torr for 180s. For the lateral growth of Bi nanowires, we sputtered a thin Cr (or SiO_2) layer on top of the Bi film. The Bi thin films were subsequently put into a custom-made vacuum furnace for thermal annealing to grow Bi nanowires by the OFF-ON method. After thermal annealing, the Bi nanowires cannot be pushed out from the topside of the Bi films due to the Cr (or SiO_2) layer. Instead, Bi nanowires grow laterally as a mean s of releasing the compressive stress.

We fabricated a self-assembled Bi nanobridge (d=192 nm) device in-situ using OFF-ON through annealing at 250˚C for 10hours. From I-V measurements taken on the Bi nanobridge device, contacts to the nanobridge were found highly ohmic. The quality of the Bi nanobridge was also proved by the high MR of 123% obtained from transverse MR measurements. These results manifest the possibility of self-assembled nanowire interconnection between various nanostructures for a variety of applications and provide a simple device fabrication method to investigate transport properties on nanowires without complex patterning and etching processes.

Keywords: Magnetoresistance, Bi Nanowires, On-Film Formation of Nanowires, In-situ Self-assembled Interconnection