Sidewall effect in a stress induced method for Spontaneous growth of Bi nanowires

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Abstract : Single-crystalline Bi nanowires have motivated many researchers to investigate novel quasi-one-dimensional phenomena such as the wire-boundary scattering effect and quantum confinement effects due to their electron effective mass (~0.001 me). Single crystalline Bi nanowires were found to grow on as-sputtered films after thermal annealing at 270 °C. This was facilitated by relaxation of stress between the film and the thermally oxidized Si substrate that originated from a mismatch of the thermal expansion. However, the method is known to produce relatively lower density of nanowires than that of other nanowire growth methods for device applications. In order to increase density of nanowire, we propose a method for enhancing compressive stress which is a driving force for nanowire growth. In this work, we report that the compressive stress can be controlled by modifying a substrate structure. A combination of photolithography and a reactive ion etching technique was used to fabricate patterns on aSi substrate. It was found that the nanowire density of a Bi film grown on 100μm×100μm pattern Si substrate increased over seven times higher than that of a Bi sample grown on a normal substrate. Our results show that density of nanowire can be enhanced by sidewall effect in optimized proper pattern sizes for the Bi nanowire growth.

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