Role of Molarity Fraction on Uniform Silicon Nanowires Fabricated by Metal-Assisted Chemical Etching

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We demonstrate controlled fabrication of vertically aligned silicon nanowires, 5-50 micrometers in length, from bulk silicon wafer by metal-assisted chemical etching method. Partially continuous gold film on p-type silicon wafer was deposited by DC sputtering. Roles of etchant compositions, molarity fraction of HF and H_2O_2 in a range of 0.8-0.9, on morphology control ranging from uniform silicon nanowires to non-uniform structure were illustrated. At a fixing etching time, not only the uniformity of nanostructure but also the length of nanowire was tailored by molarity fraction. Equilibrium reaction between HF and H_2O_2 displayed a crucial factor in structure control mechanism due to co-reaction between both etchant chemical species in silicon etching process. Rate of etching reaction and length of silicon nanowires depended on H_2O_2 concentration. The higher amount of H_2O_2 leaded to an increase of silicon nanowire length but a reduction of etching reaction rate. Further increase in HF and H_2O_2 concentration leaded to the formation of non-uniform silicon nanowires and non-well defined etching layer, respectively. At the non-equilibrium reaction between HF and H_2O_2, uniform silicon nanowire was obtained by reduction of reaction time. Additionally, we found that thickness of gold catalyst was another key factor to receive well aligned silicon nanowire. The thinner gold layer leaded to non-well defined etching layer while the thicker gold layer caused non-uniform silicon nanowire. The application of free standing uniform silicon nanowires as three dimensional sensing material will be presented.

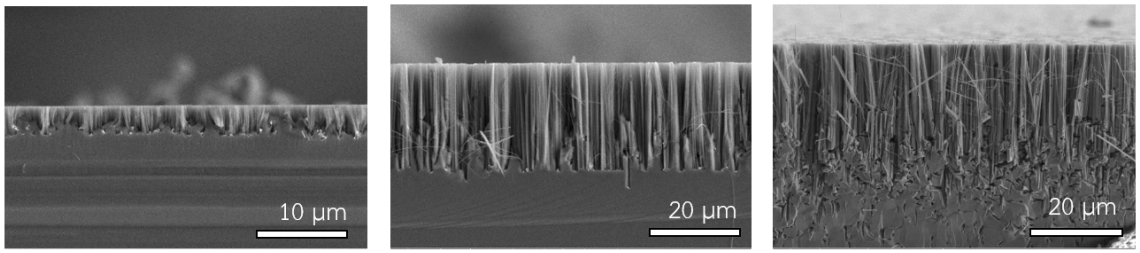

Figure 1. FE-SEM images represented (a) non-uniform silicon nanowires (b) uniform silicon nanowires and (c) non-well defined etching layer

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