Fabrication of Sealed Nano-channels Based on Sacrificial Nanotemplates by Focused-ion-beam Induced Chemical Vapor Deposition

Ajuan Cui, Wuxia Li, Qiang Luo, Zhe Liu, Junjie Li and Changzhi Gu

Beijing National Laboratory for Condensed Matter Physics, Institute of Physics, Chinese Academy of Sciences, Beijing 100190, China

liwuxia@aphy.iphy.ac.cn, czgu@aphy.iphy.ac.cn

Sealed nano-channels have a wide range of applications; the most popular applications include DNA detection, drug delivery and novel energy battery. Nano-channels also have potential applications in fundamental research such as to study the behavior (transportation, flow and reaction) of various types of materials in nanochannels. There are several methods for sealed nano-channel fabrication, for instance, reversal imprint lithography[1] and selective chemical etching[2]. Most of the existing methods involve either complex processing techniques or require chemical etching.

In this paper, a facile and reliable technique to create sealed nano-channels is developed based on the phenomenon that nanowires disappear upon the deposition of tungsten by focused ion beam induced deposition with $W(CO)_6$ as the gas precursor, as showed in figure 1. Metallic nanowires (e.g. Ag, Au, Ni) and nanotubes (e.g. BN and MWCNT) can be used as the sacrificial templates, and nanochannels with different shapes, sizes and materials types with diameter less than 100 nm, were fabricated. Some of the nano-channel fabricated was showed in figure 2. The size of the channels is related to factors mainly the size and material of the sacrificial nanotemplates, the ion beam current used for deposition and the conductivity of the substrate. By tuning these parameters, the size of the nano-channels can be controlled precisely. It is also found that the supporting substrates can be conducting, semiconducting and insulating. The shape of the nano-channel is determined by the shape of the sacrificial templates.

Most importantly, by the combination of electron beam lithography related sacrificial templates fabrication (electron beam lithography followed by metal deposition and lift-off techniques) with FIB-CVD related channel formation, regularly distributed nanowire networks/ arrays can be fabricated. The resulting nano-channels image the size, position and shape of the templates, providing a flexible, controllable and repeatable method for fabrication of large scale ordered nanochannel networks/arrays.

This work is supported by the National Natural Science Foundation of China under Grant No.91123004,11104334, 50825206 , 60871045 , 10834012 and 60801043 , and the National Basic Research Program (973) of China under Grant No. 2009CB930502.

Reference:

[1] Takashi Yoshikawa, Kenji Sogo, and Yoshihiko Hirai, Microelectronic Engineering **83** (2006) 876–879.

[2] Kyo Seon Chu, Seungwook Kim, Haegeun Chung, Joon-Ho Oh, Tae-Yeon Seong, BooHyunAn, Young Keun Kim, Jae Hyoung Park, Young Rag Do andWoong Kim, Nanotechnology **21** (2010) 425302 (6pp).

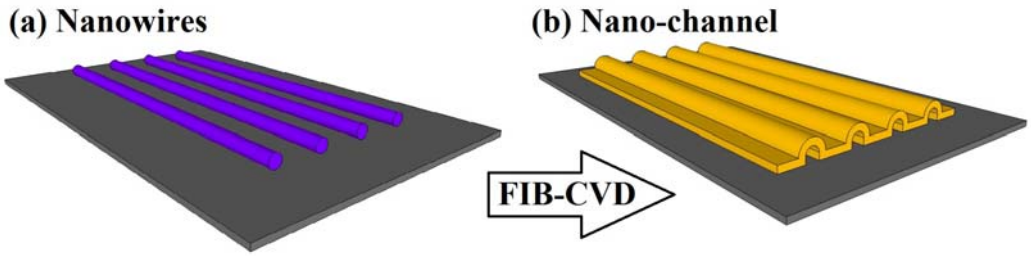

Figure 1: The Schematic Diagram of Nano-channel Fabrication Process: (a) the nanowires used as sacrificial templates; (b) nano-channels formed by FIB induced deposition of tungsten onto the nanowires.

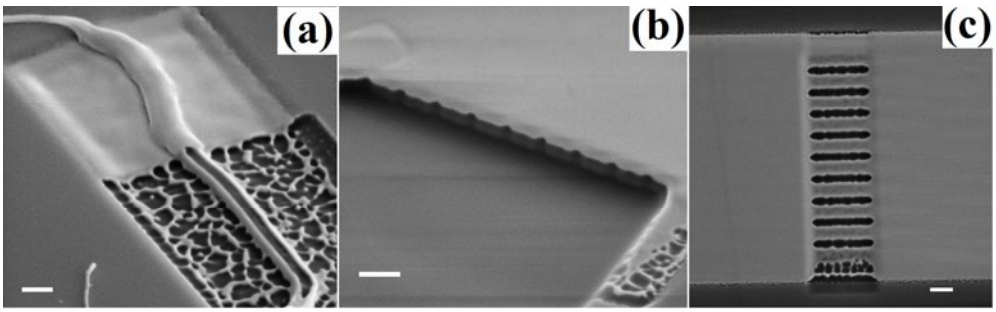

Figure 2: The SEM images of nano-channels fabricated with different sacrificial templates: (a) multi-wall carbon nanotubes; (b) Au nanowires and (c) Ni nanowires. The scale bar is 500 nm.