Low Temperature SiNWs Based Devices Fabrication for Flexible Electronic Applications

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Abstract :

Research in fabricating SiNWs (silicon nanowires) based devices on flexible substrate [1, 2] has been thriving for purpose of fulfilling the increasing market demand of portable electronic devices or lightweight electronic applications. In particular, fabricating SiNWs under the temperature lower than 300°C is the key access to SiNWs based devices fabricating on flexible substrates which are tend to melt under relative high temperature.

In order to realize low temperature SiNWs fabrication, all the process steps were taken into account. In this work, spacer technique is a promising approach to fabricate SiNWs [3]. As Illustrated in Figure 1, SiO_2 as a material step is firstly deposited by PECVD (Plasma Enhanced CVD, which process temperature is restricted under 300°C) and patterned by RIE (Reactive Ion Etching). Amorphous silicon (a-Si) film is then deposited by PECVD. Followed by anisotropic RIE, the sidewall spacers of a-Si used as nanowires would form thanks to the height difference at the SiO_2 step.

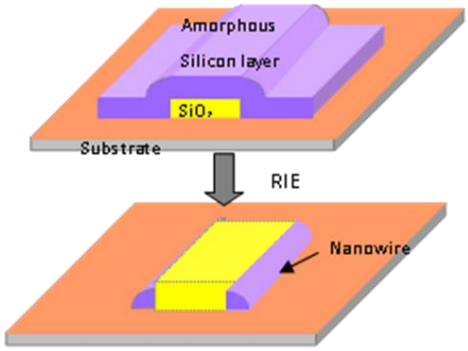
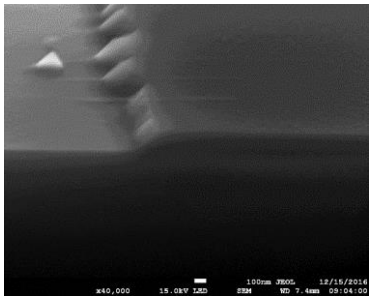
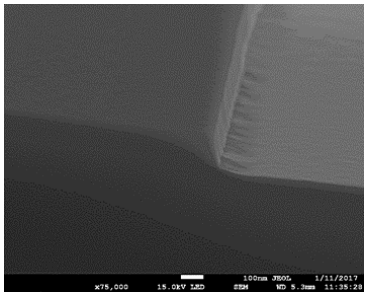


Figure 1: Fabrication SiNWs by spacer technique

As a predominant process that is responsible for the formation of material steps and thus nanowires, RIE has been investigated in detail. One can observe from Figure 2(a) is that the verticality of the SiO_2 sidewall is under very low quality before optimization. It would not be tolerated to elaborate the nanowires since the potential deposited layer can be etched completely at this sidewall. After optimizing the parameters concerning the plasma etching process, the verticality of the SiO_2 sidewall is considerably improved (see figure 2b). The corresponding RF power and LF power are 150W and 20W respectively, and the working pressure is set at 1 mTorr.



(a)



(b)

Figure 2: SEM images of etched SiO_2 step: (a) before optimization, (b) after optimization

With Optimized RIE process the SiNWs can be prone to adhere to the SiO_2 sidewalls, which could lead to the better morphology of SiNWs that present promising electrical properties. Moreover, the anisotropic RIE of amorphous silicon should be further optimized to validate the low temperature SiNWs fabrication on low cost flexible substrates.

References :

[1] McAlpine, Michael C., et al. "Highly ordered nanowire arrays on plastic substrates for ultrasensitive flexible chemical sensors." *Nature materials* 6.5 (2007): 379.

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[3] Demami, Fouad, et al. "Silicon nanowires based resistors as gas sensors." *Sensors and Actuators B: Chemical* 170 (2012): 158-162.