Influence of the SiO$_2$ surface functionalization on the growth of Ge nanostructures by LPCVD

A. C. G. Rocha
S. N. M. Mestanza *
Federal University of ABC, Santo André, SP, Brazil

ABSTRACT

During the last years, Germanium nanostructures (Ge-ns) embedded in insulators as silicon oxides (SiO$_2$) have been studied extensively. One of the reasons is that they have potential applications for non-volatile memories (flash type).

To obtain the Ge-ns there have been exploited different techniques: Laser Ablation, Ion Implantation, Co-Sputtering, Low Chemical Vapor Deposition (LPCVD). Works reported in the literature have shown that samples which SiO$_2$ surface were treated with HF (0.01%) exhibited good results [1,2]. But it is well known that, even when the HF solution is highly diluted, it etches the SiO$_2$ surface. This fact could be very important when developing memory devices with tunneling oxides of only a few nanometers.

In this work we propose the functionalization of the SiO$_2$ surface with H$_2$O-DI as an alternative to avoid the etching. We also propose the analysis of a sample without any surface treatment to verify that the functionalization is a process of great importance on the growth of Ge-ns. We report the preliminary results of the functionalization of the SiO$_2$ surface treated with two different conditions: H$_2$O-DI and HF (0.01%) at room temperature. Besides, results of the sample without functionalization are also reported. Ge-ns were grown on this surface by LPCVD technique. Atomic force microscope (AFM) technique was used to characterize the samples.

The results analysis consists in two parameters: mean height of the nanostructures and tridimensional morphology. Three software’s were used during the data collection and histograms development: Image Analysis 2, Gwyddion 2.9 and Excel 2003.

Preliminary results show that Ge-ns with very similar characteristics have grown on the samples treated by each method, except the sample without treatment. The sample treated with HF (0.01%) shows a mean height value of 91nm ± 11.0% while the one treated with H$_2$O-DI presents 78nm ± 11.5%. The third sample does not show a meaningful growth, as expected. Figure 1 shows the mean height results for the three samples analyzed.

![Mean Height Histogram](image)

Figure 1. Mean height histogram of the samples.

The tridimensional morphology analysis shows that Ge-ns have grown under hemispheric geometry. E. S. Marins et al [3] obtained transmission electron microscopy (TEM) and scanning electron microscope (SEM) images that evidenced the hemispheric geometry of Ge-ns from similar samples treated with HF (0.01%).
Figure 2 displays a scanning electron microscopy (SEM) micrograph of Ge-nanocrystals (Ge-ns) obtained by LPCVD.

![Figure 2 SEM images of Ge-ns grown by conventional LPCVD](image)

We predict the same geometry for the Ge-ns from sample treated with H$_2$O-DI by analyzing statistic data. Figures 3 and 4 show the cross section histogram of the samples functionalized with HF (0.01%) and H$_2$O-DI.

![Cross Section Histogram - H$_2$O-DI](image)

**Figure 4** Cross section histogram of the sample functionalized with H$_2$O-DI.

The authors would like to acknowledge to CCS/Unicamp, for the AFM measurements, Dr. N. C. Frateschi and Dr. I. Doi for helpful discussions. The financial support from the Brazilian agency CNPq and UFABC is also acknowledged.

REFERENCES


* Corresponding author, electronic mail: nilo@ufabc.edu.br