Implantation and amorphization induced by Focused Ion Beam

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Focused Ion Beam (FIB) is a powerful lithography technique which presents the main advantage to be maskless. Although, milling with a FIB permits to control at nanometer scale, the defects induced in the substrate and the dose of implanted ions. For the past few years, LMAIS (Liquid Metal Alloy Ion Source) appeared as an alternative to gallium FIB source. Gold, germanium and silicon can be used for ionic lithography. The last two elements are useful as they do not contaminate respectively Si and Ge substrate [1].

After studying the different phenomena related to the interaction between ion and matter depending on the ion kinetic energy, the work has been focused on ion implantation and substrate amorphization.

According to ion implantation, a comparison between Stopping Range of Ions in Matter(SRIM - Figure 1) simulations and experiments using EDX analysis was realized.

The substrate amorphization occurs because of the high-energy of Ga ions. Many interactions such as knock-on take place in the crystal. The collisions cascade destroyed the initial lattice and an amorphous phase is created. In Figure 2, two layers of silicon are present, an amorphous layer because of Ga implantation and the rest of the substrate which is crystalline.

To cure the defects, an annealing of the sample has to be done, in order to recrystallize the amorphous layer induced by FIB process.

Many nanostructures can be fabricated by FIB : nanowires, nanodots, Mie resonators [2], where the FIB is used to organize accurately the silicon top layer before the dewetting process in this last case.

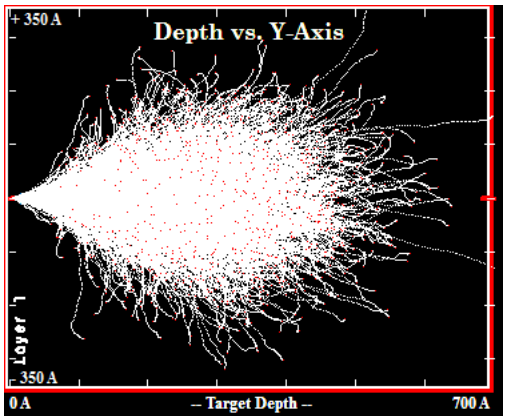

Figure 1 : SRIM simulation - 30 kV - Ga on Si

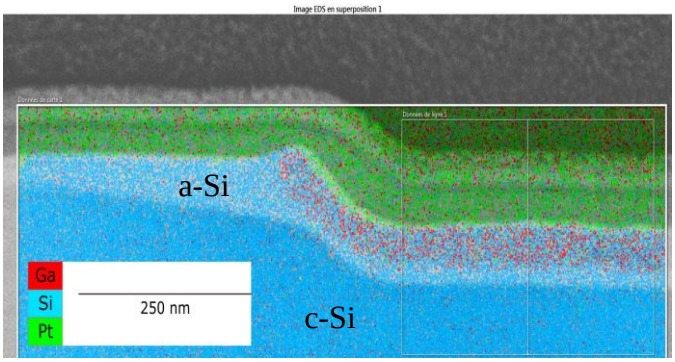

Figure 2 : EDX analysis of a sample after 30 keV Ga implantation

[1] Benkouider et al., «Ultimate nanopatterning of Si substrate using filtered liquid metal alloy ion source-focused ion beam» *Thin film solid,* vol. 543, pp. 69-73, 2013.

[2] Abbarchi et al., «Wafer Scale Formation of Monocrystalline Silicon-Based Mie Resonators via Silicon-on-Insulator Dewetting» *ACS Nano,* vol. 8, pp. 11181-11190, 2014.