Formation of n and p Regions in (114) and (5 5 12)-Silicon Substrates

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Silicon is the most widely used semiconductor for the fabrication of electronic devices [1]. Diffusion and ion implantation, the main processes used for doping silicon, depend on the substrate orientation. Therefore, these processes have been extensively studied using the common low index silicon orientations; nevertheless, there is a lack of information about diffusion and implantation of dopants on high index silicon substrates.

An ideal high-index silicon surface consists of a periodic array of low-index terraces separated by steps of monatomic height; however, the actual surface morphology of high-index Si is usually not ideal. In the family of Si surfaces oriented between (001) and (111), only a few high-index surfaces form stable planar reconstructions [2]: (114), (113) and (5 5 12). In this work we study the diffusion and ion implantation in Si(114) and Si(5 5 12) substrates. These particular orientations were chosen because they present a periodic row-like surface structure, with a large unit cell, and form a planar stable surface reconstruction; these characteristics can be useful for developing novel devices and technologies dependent on the crystalline orientation [2].

The n and p regions were fabricated on Si(114) and Si(5 5 12) by diffusion and implantation of phosphorus and boron; low index substrates were also used as a reference. Diffusions were conducted under both, oxidizing and a non-oxidizing ambient, and for different temperatures in order to determine the oxidation enhanced diffusion (OED) [3] as a function of the crystal orientation. Implantations were conducted under diverse conditions of energy, doses, thickness oxide, beam angle, and annealing. An electrochemical CV profiler was used in order to obtain de doping profiles.

For our experimental conditions we found the following:

- The boron profile is quite dependent on the crystal orientation (Fig. 1). The depth junction increases according to (111)>(5 5 12)>(001)>(114).
- The phosphorus profile in (5 5 12) showed similar characteristics to that obtained for (114) and depends weakly on the beam angle (Fig. 2).

Boron and phosphorus diffusivity should depend on the crystal orientation because the oxidation velocity, and thus the OED, depends on the orientation. Further details will be presented at the conference, and the results will be discussed in terms of the OED and ion channeling [1,3,4], which are strong functions of the crystal orientation.

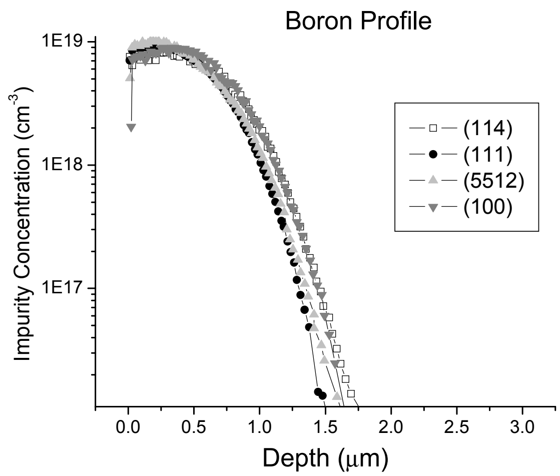

Fig. 1. Boron profile in Silicon as a function of the crystal orientation.

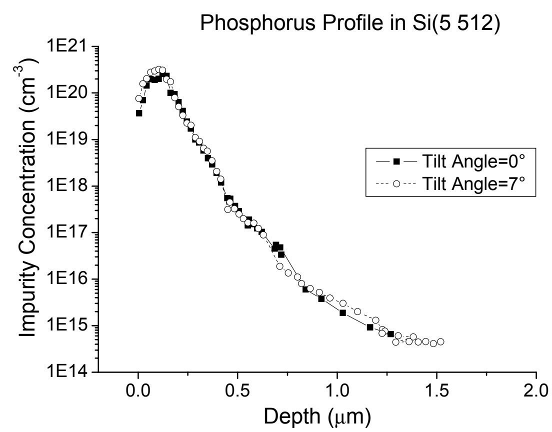

Fig. 2. Phosphorus profile in Si(5512) for two different beam angles (Similar results were found for Si(114)).

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