

MODELLING AND SIMULATION OF THE IMPURITY DIFFUSION AND RELATED PHENOMENA IN SILICON AND POLYSILICON SYSTEMS IN MICROFABRICATION AND MICROMACHINING TECHNOLOGIES

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Abstract - In this paper there are presented our results concerning the modelling and simulation diffusion of the boron, phosphorus, antimony, arsenic as doping impurities in silicon and polysilicon layers and gold diffusion as a recombination centre in silicon and its influence on the forward characteristic of the p-n junction, as well as some related phenomena like the generation of the misfit dislocations induced by the doping impurities and the gettering process of metallic impurities, with application in the microfabrication technologies. The results on the boron diffusion were used in the simulation of the self-limited etching process of silicon boron doped layers for the bulk micromachining fabrication and the powerful methods as XTEM and SIMS were used for the characterizations of the polysilicon layers, allowing to propose a doping – restructuring mechanism of polysilicon during the phosphorus diffusion in the surface micromachining technology for the thin membrane achievement.

Keywords: Impurity Diffusion, Modelling and Simulation, Misfit Dislocations, Gettering, Etching, Silicon and Polysilicon, Doping-Restructuring Model, Micromachining and Microfabrication

1. Introduction

The knowledge of the material properties of the semiconductor in the delimited specific regions of the semiconductor both before and after processing is one of the fundamental tasks for the achievement of the microelectronic and microsystem devices in order to accurately design their configuration and to control on this way the desired useful parameters [1]. The fulfilment of these fundamental requirements explains the considerable efforts to investigate the material properties at the atomic scale [2] and to formulate in physical and mathematical terms the intimate atomic processes in the semiconductor lattice [3].

In this paper there are presented our contributions to the description of the atomic diffusion in silicon of boron as a *p*-type impurity in silicon and of phosphorus, antimony and arsenic as *n*-type impurities, by using conventional (thermo-chemical) and non-conventional (doped polysilicon, multilayer systems, implantation, laser - assisted annealing) techniques, as well as the gold diffusion and its influence on the forward characteristic of p-n junction and the gettering phenomena induced by the diffusion in silicon wafers. As a related process during the phosphorus and boron diffusion in silicon at high concentrations, the generation of the misfit dislocations, defined in terms of the critical conditions and the corresponding variation of the characteristic parameters (critical diffusion time and temperature) is calculated and expressed in analytical form.