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Indirect Diffusion Mechanism of Boron Atoms in Crystalline and Amorphous Silicon

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ABSTRACT

The diffusion of B atoms in crystalline and amorphous Si has been experimentally investigated and modeled, evidencing the indirect mechanism of these mass transport phenomena. The migration of B occurs after interaction with self-interstitials in crystalline Si (c-Si) or with dangling bonds in amorphous Si (a-Si). In the first case, an accurate experimental design and a proper modeling allowed to determine the microscopic diffusion parameters as the B-defect interaction rate, the reaction paths leading to the diffusing species and its migration length. Moreover, by changing the Fermi level position, B atoms are shown to interact preferentially with neutral or doubly positively charged self-interstitials. As far as the amorphous case is concerned, B diffusion is revealed to have a marked transient character and to depend on the B concentration itself. In particular, boron atoms can move after the interaction with dangling bonds whose density is transiently increased after ion implantation or permanently enhanced by the presence of boron atoms themselves. Unexpectedly, B diffusivity in a-Si is seen to be orders of magnitude above than in c-Si and to depend on the thermal history, i.e. the relaxation status of the amorphous phase. These data are presented and their implications discussed.