ENHANCED LOW-TEMPERATURE B ACTIVATION IN Si VIA NON-AMORPHIZING HIGH-ENERGY ION IMPLANTATION

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The ability to achieve efficient electrical activation of B in Si at low temperatures (low-T) has been an important goal in Si processing research. The main limitation to achieve efficient low-T activation is related to the clustering phenomenon associated with B atoms, which is enhanced by the presence of interstitial atoms. The most successful approach to achieve low-T activation has been via epitaxial regrowth of amorphized Si implanted with B, where B clustering is found to be reduced. However, this approach faces limitations when the amorphized Si has an interface with a non-Si region. This is a likely situation with devices fabricated on Si-on-Insulator (SOI) substrates. Here, a thin active device layer of Si sits on an insulator, like SiO_2. Consequently, epitaxial regrowth into a single crystal is not possible and hence alternate approaches must be discovered. Here, we demonstrate a new approach to achieve enhanced B activation at temperatures as low as 400^oC. The approach relies on generating a large concentration of *excess* vacancy clusters prior to the B implant. These excess vacancies are generated by high-energy ion implantation in Si using 2-MeV Si in the dose range of $2x10^{15}$-$1x10^{16}$ atoms/cm^2. Amorphization is suppressed by holding the substrate at slightly elevated temperatures (~70^oC). We show that the electrical activation of 40-keV, $2x10^{14}$ cm^{-2} B implants is enhanced by more than a factor of 2 in the temperature range from 400 to 800^oC over the case without vacancies. We also discuss the vacancy concentration dependence of B-electrical activation. This approach will potentially allow low-T activation of B in Si on heterogeneous substrates.

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