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Impact of Surface Preparation for n-type Si:P and p-type SiGe:B Semiconductors on Low Resistance Silicide Contacts

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Abstract

In our study, we evaluate effective silicon and germanium oxide reduction by two surface treatments to achieve low contact resistivity at the semiconductor/ metal interface. These chemistries, one alkaline and the other an acidic fluorine-based treatment, were utilized on epitaxial n-type Si:P and p-type $Si_{1-x}Ge_x$:B (x=0.47) substrates to isolate any unique effects that may be present on doped, n-type and p-type semiconductor surfaces. To mimic plasma damage and surface conditions in an integrated process flow for actual logic devices, X-ray photoemission spectroscopy (XPS) characterization was performed on simplified blanket films after NF_3-based gas cluster ion beam (GCIB) exposure and subsequent aqueous treatments. Si:P and SiGe:B surfaces both demonstrated an increase in SiO_2 concentration after GCIB exposure, with SiGe:B surfaces showing a preferential SiO_2 surface oxidation. Subsequent acidic treatment showed reduction in SiO_2 concentration on both epitaxial surfaces, with the alkaline (basic) treatment showing little change in surface composition. Electrical characterization on simplified contact structures showed a benefit in contact resistivity of 15-23% in Si:P and 10-13% in SiGe:B for the chemistries evaluated.