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Synthesis and characterization of self-assembled, high aspect ratio nm-scale columnar silicon structures

Abstract

The aim of this work is to synthesize nm-scale columnar structures in Si principally for solar cell applications. These structures are also desirable as templates for heteroepitaxial growth of Si_xGe_{1-x}. A nanostructured layer is instrumental in facilitating pseudomorphic heteroepitaxial growth of Si_xGe_{1-x} layers since it can help reduce lattice mismatch as well as thermal expansion mismatch, thus, leading to Si-based high efficiency solar cells at lower cost. A simple yet promising method was chosen to synthesize randomly distributed, nm-scale columnar structures. This metal assisted chemical etching (MACE) technique uses metal-induced oxidation of silicon to anisotropic trenches. Preliminary results indicate that nm-scale columns as characterized by field emission scanning microscopy (FE-SEM) consist of fine pores running parallel to the wafer surface and deeply etched anisotropic columns perpendicular to the surface. All etching work was carried out on (100) orientation Si wafers. Results indicate strong dependence on solution concentration both in terms of profile and etch rate. Optical characterization based on spectral reflectance and transmission measurements have been employed in characterizing the nm-scale surfaces. Initial studies indicate low reflectance and high absorption with increasing depth of the nanostructures.

Keywords; MACE; Si nanopillars; Solar cells; Heteroepitaxial growth; Self-assembled nanostructures