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Cu-Assisted Chemical Etching Process for Fabrication of Black Silicon Substrate

Black silicon is surface modification of silicon like nano-structure, that significantly decrease reflectivity of the silicon wafer surfaces. An effective and economical fabrication process for black silicon is metal-assisted chemical etching(MACE) method which is neither high energy consuming nor complicated process. The MACE method usually involves two steps: metal deposition and chemical etching. The copper deposited on the Si wafer surface can attract electrons from the silicon wafer surface and cause the oxidation of Si to SiO₂. After the metal deposition, the Si wafer is immersed in etchant. The as-formed SiO₂ is etched away by HF and a pit is produced under each particle. In this paper, Cu metal particles were deposited using a solution of Cu(NO₃)₂, HF and DI water. The wafers were then etched by HF and H₂O₂ solution. To investigate the effects of HF concentration on the surface morphology, the HF concentration was changed from 1.4M to 2M. Through SEM, we observed that large Cu particles were deposited at an HF concentration of 1.4M and showed high reflectance. This is because Cu ion did not uniformly and completely react at a low HF concentration. With an increase of the HF concentration, the size of Cu particles on the surface became smaller and uniform. The reflectance of the textured surfaces ranged from 4% to 3.2% at wavelengths between 400 and 1000 nm. As a result, the lowest reflectance of 3.2% was obtained at concentrations of 1.8M and 0.1M for HF and Cu(NO₃)₂ respectively.

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