Wet Chemical Etching of Native Oxides on Si and GaAs Studied by Ion Beam Analysis (IBA)

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Native oxides grow on many surfaces including semiconductors such as Si and GaAs. This growth negatively impacts semiconductor-based devices because an amorphous native oxide prevents the growth of high quality epitaxial crystalline layers on semiconductor surfaces. It also increases contact resistance when metal contact is made at the surface of a semiconductor, making devices less performant. The purpose of this project is to compare wet chemical etching of Si and GaAs as well as to quantify the oxide thickness on Si and GaAs. Ion Beam Analysis (IBA) combining Rutherford Backscattering Spectrometry with ion channeling and MeV oxygen nuclear resonance measures native oxides on Si and GaAs wafers before and after etching. Data analysis was conducted by matching Rotating Random IBA spectra to SIMNRA simulations, until the oxygen coverage correlated to matching data with 99% accuracy. Native oxides on Si(100) wafers were found to contain 13.3 x 1015 at/cm2 or 13.3 oxygen monolayers (ML). After an HF-based etch, Si(100) exhibits only a 11.6 ± 3% reduction in oxygen. GaAs native oxides on wafers were to found contain 7.22 oxygen ML. After a proprietary etch, GaAs native oxides were reduced by 49.1 ± 4%. This difference in reducing native oxides thickness can be attributed to different wafer re-oxidation rates. This study quantifies both the effectiveness of wet chemical etching and the native oxide thickness on both Si and GaAs semiconductor wafers, finding that wet chemical etching is more effective for GaAs than Si.

Awards Won:

Arizona State University: Arizona State University Intel ISEF Scholarship