Etching of $SiO_{1.7}$ films in supercritical CO2

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Abstract

It is getting harder to meet both the technical and economic demands to make smaller and faster microelectronic devices. The purpose of this research is to minimize the amount of water, chemicals and energy used in etching processes by implementing a dry process for etching silicon oxide films instead of a treatment based on water. This was accomplished with HF dissolved in supercritical CO_2 ($scCO_2$). It was confirmed by both ellipsometry and Fourier Transform Infrared (FTIR) spectroscopy that a $SiO_{1.7}$ film deposited using chemical vapor deposition could be etched with HF dissolved in $scCO_2$at 140-150°F and 2500 psi. A reaction using a 70%HF/pyridine complex in $scCO_2$ showed a reaction order of 0.57 ± 0.1 while a 49%HF/H_2O mixture in $scCO_2$ had an order of 0.67 ± 0.3. In all cases, the HF/H_2O mixture etched faster than the HF/pyridine. Example etch rates at 4 mM of 8.9 nm/min for HF/H_2O and 4.9 nm/min for HF/Py were calculated. A cloudy residue identified as pyridine did appear on the sample surface after etching with the HF/pyridine, which may have caused the lower etching rates. Some inconsistencies were observed in the repeatability of the etching experiments as well as unevenness in the etched surfaces. Future work looks to examine more closely the sample surface morphology after etching as well as to identify the cause of the varying etch rate data.