Issue & Opportunity

The project goal is to characterize the dissolution behavior of butyltin hydroxide oxide in polar organic solvents.

SEMICONDUCTOR DEVICES & PHOTORESISTS

Modern electronics compute use semiconductor devices made from thin film materials. Patterns are etched in thin films and layered atop one another to form the semiconductor devices. Pattern feature size has a major effect on final device size and functionality. Patterns can be etched in multiple ways; this project focuses on a photore sist, which changes solubility upon exposure to radiation. When a pattern is formed by radiation exposure, the parts of the film outside the pattern can be dissolved in a chemical solvent. The remaining film is the desired layer; further layers can be added in the same manner to form a device.

The minimum feature size generated in this manner depends on the photore sist used. Butyltin hydroxide oxide (BuSnOOH or butyltin) shows promise as a high-resolution thin film photore sist. Its dissolution behavior is not well-characterized, so the optimal solvent for development is unknown. This project was created to characterize the dissolution behavior of butyltin and potentially find an optimal solvent.

Butyltin converts to tin oxide upon exposure to electron-beam radiation. Butyltin hydroxide oxide (BuSnOOH or butyltin) shows promise as a high-resolution thin film photore sist.

Butyltin can be developed using electron beam radiation. When butyltin develops it reacts to form tin oxide, an insoluble semiconductor material. The reaction mechanism is shown below:

Baking the films mimics development due to electron beam radiation. Butyltin films were baked at 70, 100, 125, 150, 175°C to remove residual solvents. Films were not heated above 200°C because butyltin fully reacts at that temperature. Heating the films slows the dissolution rate allowing for clearer understanding of dissolution behavior. The films have the potential to partially develop during baking, which would cause an insoluble layer of tin oxide to form. This layer would remain behind after the dissolution trial.

CONCLUSIONS

The effectiveness of 2-heptanone confirms the hypothesis that larger polar organic solvents will more effectively dissolve the butyltin films. The effect of other factors such as the strength of the molecular dipole could be tested in future work. Further thermal trials would determine if the remaining mass was due to baking, and if so, what the temperature dependence was.

An SOP for the QCM has been developed for current and future researchers to reference when continuing this project.