

New sampling module for ultra-low level cation, anions, and organic acids in air/gases

Balazs NanoAnalysis

Introduction

With increased process complexity in integration, semiconductor fabs become more concerned with contamination sources, such as airborne molecular contamination (AMC) and gas impurity. These contaminants lead to process defects in film deposition, photolithography processes and ion implant, whereas acid gases could corrode critical components or react to form salts causing hazing. Lower detection limits for these contaminants are required as feature sizes decrease to 5 nm.

Sampling of AMC or bulk gases is usually conducted with impingers, which requires disassemble, assemble, changing the sampling liquid in and out for analysis. External contamination may occur during these procedures, due to exposure to air or human handling. It is important to ensure the cleanliness of these impingers for the contaminants of interest prior to using them to collect air or gas samples. These concerns increases the uncertainty in lowering the detection limit (DL) of these sampling systems.

Balazs has developed a new sampling module for the collection of ammonia, anions, and organic acids in the air/gases, which has a much lower detection limit compared with other commercial available samplers. Air/gases are introduced into the sampling module through ¼" tubes, then contaminants get trapped by the sampling matrix through a nozzle that produces very small bubbles, and finally exhausted to an external port. A preparation and closed sample introduction procedure were also developed for this sampling module, with no air exposure. The whole assemble process is conducted under nitrogen gas or ultrapure water, and the sampling module is connected to our ion chromatography instrument directly for analysis. An ultraclean material was used in the construction of this sampling module and background contaminants are extremely negligible.

This sampling module has been successfully used in semiconductor industry for several years. Ammonia, anions, and organic acids from the preparation, sampling and analysis of shipping blank were undetected (DL 0.01 ppbv) for seven replicates. This sampling module has also proven to be very stable for monitoring air contaminants. For example, periodic sampling of AMC process with this sampling module yielded process ion contamination results that could be related with production yields.

Spiking studies for ammonia has been conducted to see whether ammonia would evaporate from the sampling module after capturing. Results showed that evaporation was negligible under the testing conditions sampling purified nitrogen. Planned studies include spiking low levels of anions and organic acids into a sample matrix will be conducted.

This study developed a new sampling module for ultra-low level ammonia, anions, and organic acids in air or gases. This sampling module has much lower detection limit and has shown favorable performance in semiconductor industry. We can test total inorganic acids and bases to be less than 10pptV. Contamination due to human handling and air exposure is minimized for this sampling module, which could be used for contamination test for impurity of gases used in tools, as well as cleanroom air. All these will benefit semiconductor industry in device yield and performance.