Development of a robust Fourier-Transform ion trap for semiconductor manufacturing

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Semiconductor manufacturing has a growing demand for in-line process control metrology as the pressure on cost efficiency and quality is steadily increasing. Especially endpoint detection is a crucial factor for etch processes, as it determines wafer throughput and quality. With shrinking node sizes and thus, decreasing open areas in etching currently used optical emission spectroscopy (OES) reaches its physical boundaries. Furthermore, the chemistry of many etch processes are not fully understood and a deeper insight would lead to process optimization. However, using mass spectrometers in etch processes can be challenging due to the aggressive chemicals used in wafer etch and chamber cleaning. This is why the main requirements for a mass spectrometer in this field are its robustness, respectively corrosion resistance and measurement speed. A Fourier Transform Ion Trap, together with a pulsed gas inlet, meets those requirements. The absence of an ion detector and the small gas load inside the instrument, together with only gold plated or ceramic surfaces lead to a high robustness against etch gases like Cl2, BCl3, HBr or HF or depositing gases like TBAs (Tetrabutylarsine) or TEGa (Triethylgallium). The sampling rate is up to 2 Hz for a full mass spectrum, which is sufficient for most processes, as typical process times are in the range of 5-20 s. The instrument has proven its applicability in etch endpoint detection, process optimization of cleaning or etch processes and process diagnostics like the understanding of first wafer effects.