

Development of Low GWP Emission Si Etching Process

-In-situ monitoring technique on DRIE process for high rate, high aspect ratio etching-

Junji Ohara, Takuya Iwasaki

Abstract

Keywords: Monitoring, DRIE, Feedback, OES

- ◆ Process monitoring with optical emission spectroscopy has been developed, because combination of the monitoring and feedback control make possible high rate, high aspect ratio Si etching in order to reduce emission of high GWP gases.
- ◆ The critical moment when the bottom protection layer is removed in the DRIE process has been observed by the developed technique.
- ◆ The simulation result shows that the feedback control based on the monitoring result realizes higher rate than normal DRIE process.

Introduction

- For Si deep etching, (ex.TSV formation), the high rate, high aspect ratio etching technique is needed in order to reduce emission of high GWP gases.
- In the conventional process, higher etch rate technique leads to degradation of etching anisotropy.
- The real time monitoring technique and feedback process control have been developed in order to resolve the trade-off between high rate and high aspect ratio.

Methods

- Due to non interaction, The optical emission spectroscopy (OES) has been adopted as the monitoring methods.
- The observation of protection layer remaining time on trench bottom (δT_1) and sidewall (δT_2) during the DRIE process has been intended.
- The effect of the feed back process, 2-level bias RF control based on the observation of δT_1 and δT_2 (Fig.1), has studied by the simulation method.

Results

- The δT_1 has been monitored by intensity variation of F* and SiF*(Fig.2).
- The δT_1 dependency on cycle number and bias RF power has been certified(Fig.3).
- The simulation results show the 2-level bias control based on monitoring results realizes higher etch rate than the conventional one(Fig.4).

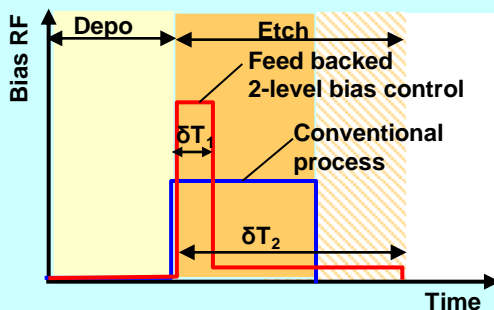


Fig. 1. The feedback process.

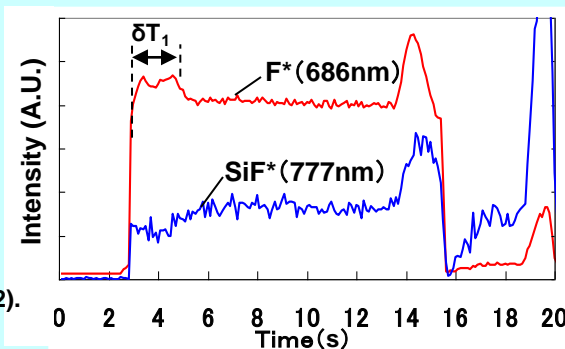


Fig. 2. Monitoring results during DRIE.

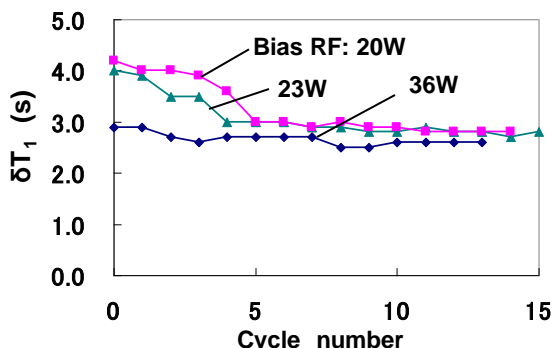


Fig. 3. The δT_1 dependence on cycle number and bias RF.

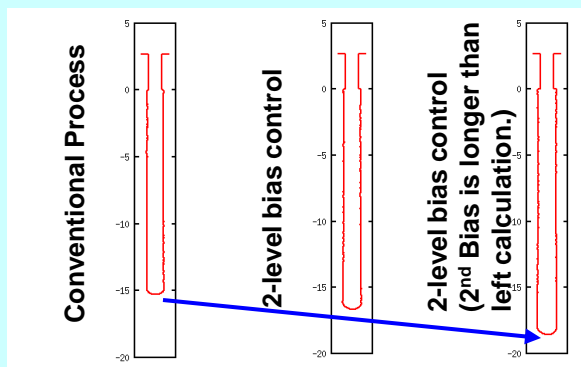


Fig. 4. Plasma Etching Simulation results of Bosch Process.

Summary

- The feasibility of higher rate technique using In-situ process monitoring and feedback control has been confirmed.