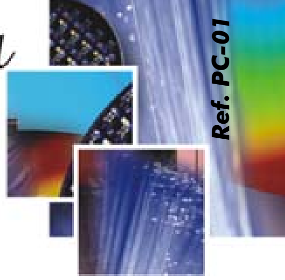


Ref. PC-01

Application Note

In-Situ Process Control: Photomasks etching

Dr. Laurent Richeboeuf - Application Scientist - Thin Film Division

PlasmaScope
DigiCPM

Summary

This note describes how the Optical Emission Spectroscopy (OES) technique can be easily used to control in-situ, the etching of photomasks, used for mass production devices.

Introduction

Photolithography is an indispensable technique for microelectronic device production, as it defines the edges of patterns on semiconductor wafers.

The wafer is covered by a photosensitive resist layer. The areas to be etched are exposed to UV light that is projected through a photomask.

Photomasks are usually based on a Quartz substrate covered by a specifically designed pattern of Chromium. The Photomask is therefore a critical element for the photolithography process and the accuracy of photomask etching is therefore an important phase of microelectronic technology.

Intrumentation

The PlasmaScope (and DigiCPM) system consists of an OES CCD sensor coupled with windows-based user friendly software. This instrument allows both process control monitoring and endpoint detection. The flexibility of the system makes it suitable both for R&D (PlasmaScope) & mass production control (DigiCPM).

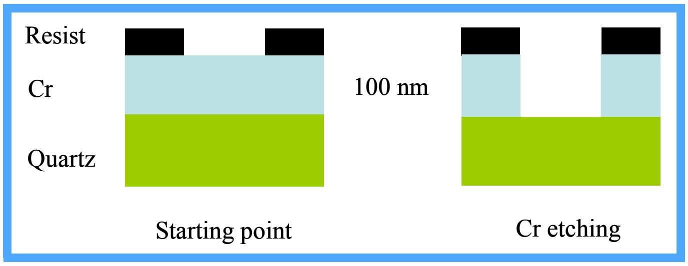
Procedure

The OES signal is obtained from the reactor's side window through an optical fiber. OES CCD is a fast and accurate non-intrusive technique, which allows in-situ & real-time layer interface detection.

After recording a run the best emission lines and endpoint algorithms can easily be determined. The user friendly multitasking capabilities of the PlasmaScope makes plasma monitoring and endpoint detection easier for various materials & plasmas conditions.

Measurement

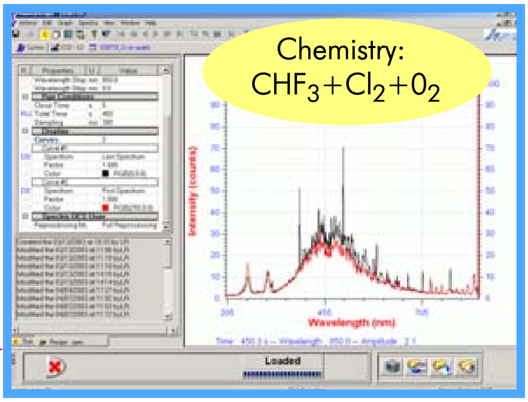
Photomasks are etched down to reach the Cr/Quartz interface. Cl_2, O_2 and CHF_3 based chemistry. Open area: from 1 to 100%.

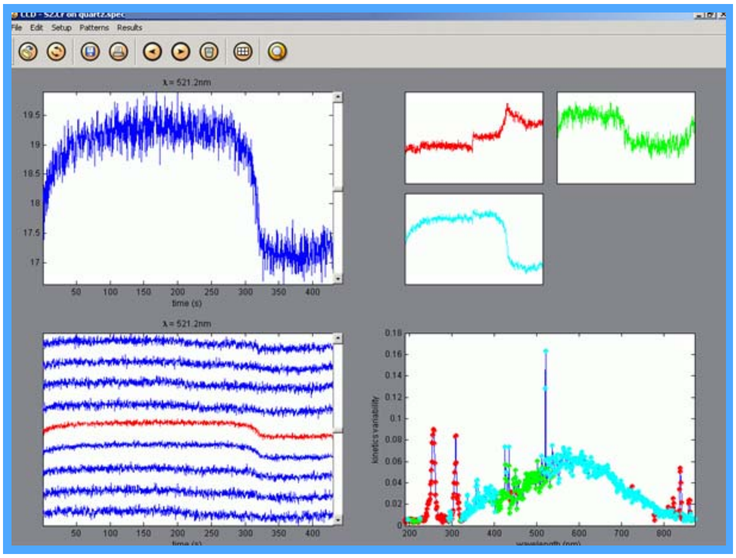


Analysis & Recipes Creation

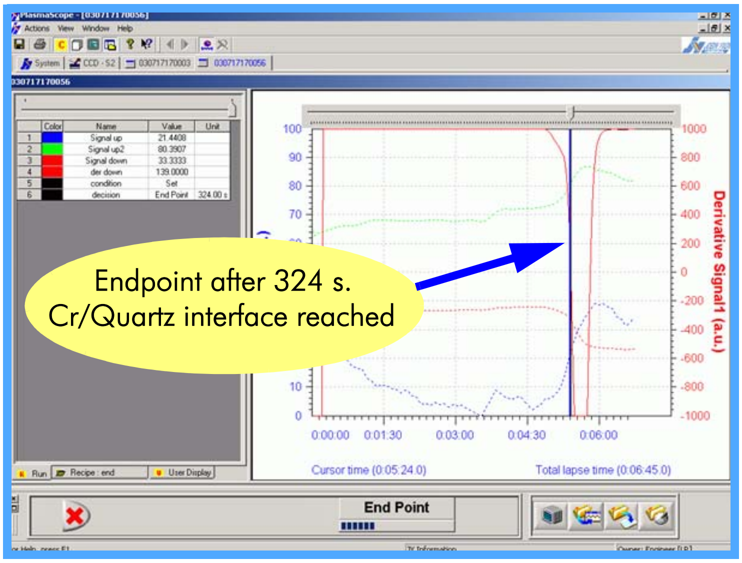
After acquisition of the entire plasma emission spectra versus time, the most suitable wavelengths to control the process step are tracked and selected. The PlasmaScope software shows the change in the intensity of these wavelengths, along with their derivatives or any other suitable algorithm (ratio, spectral range,…). Any of these can be easily incorporated into suitable endpoint recipe that is specific to the process.

Spectra acquisition, whole plasma emission follow-up in real-time


Chemistry: $CHF_3+Cl_2+O_2$



Relevant wavelengths pattern research, using AutoPattern software. The program detects the patterns for each wavelength. The figure shows an example of three detected patterns.



	Color	Name	Value	Unit
1	🟦	Signal up	21.4408	
2	🟩	Signal up2	80.3907	
3	🟥	Signal down	33.3333	
4	🟥	der down	139.0000	
5	⬛	condition	Set	
6	⬛	decision	End Point	324.00 s

Endpoint after 324 s.
Cr/Quartz interface reached

Using relevant wavelengths, the recipe can be created. Real-Time algorithms follow-up for endpoint detection.

Conclusion

PlasmaScope is a powerful OES CCD technique based system to control photomasks etching. Use of the built-in AutoPattern software, allows the most relevant wavelengths to be identified, this facilitates rapid Endpoint recipes development. Simultaneous rising and falling edges observed on several selected lines and plasma bands show the Cr/Quartz interface presence. These changes trigger the appropriate endpoint condition set in the recipe and this automatically stops the process when the interface is detected.

France
Z.A. de la Vigne aux Loups
5, avenue Arago
91380 Chilly Mazarin
Tel: +33 (0)1 64 54 13 00
Fax: +33 (0)1 69 74 88 61
E-mail: tfd-sales@jobinyvon.fr

USA
3880 Park Avenue
Edison, NJ 08820
Tel: +1-732-494-8660
Fax: +1-732-549-5125
E-mail: info@jobinyvon.com

JY Germany: +49 (0)89 4623 17-0
JY Italy: +39 0 2 5760 3050
JY Japan: +81 (0)3 3861 8231
JY UK: +44 (0)20 8204 8142
JY China: +86 (0)10 6849 2216
JY Korea: +82 (0)2 576 8650

JOBIN YVON HORIBA