Optical Emission Spectra 신호와 다변량분석기법을 통한 Fluorocarbon에 의해 오염된 반응기의 RF 플라즈마 세정공정 진단

RF Plasma Processes Monitoring for Fluorocarbon Polluted Plasma Chamber Cleaning by Optical Emission Spectroscopy and Multivariate Analysis

장해규[a*], 이학승[b], 채희엽[a,b]
[a*]성균관대학교 나노과학기술학과, [b]성균관대학교 화학공학부 (E-mail:hchae@skku.edu)

초 록: Fault detection using optical emission spectra with modified K-means cluster analysis and principal component analysis are demonstrated for inductive coupled plasma cleaning processes. The optical emission spectra from optical emission spectroscopy (OES) are used for measurement. Furthermore, Principal component analysis and K-means cluster analysis algorithm is modified and applied to real-time detection and sensitivity enhancement for fluorocarbon cleaning processes. The proposed techniques show clear improvement of sensitivity and significant noise reduction when they are compared with single wavelength signals measured by OES. These techniques are expected to be applied to various plasma monitoring applications including fault detections as well as chamber cleaning endpoint detection.

1. 서론

Plasma etching has been used for pattern transfer during fabrication of nano-scale devices. In plasma reacter, the plasma chamber is polluted by by-product such as fluorocarbon. That is, the endpoint detection (EPD) is essential. In addition, the stable maintenance of process condition is necessry for plasma processes. Commonly, optical emission spectroscopy (OES) with a viewport has been used for plasma diagnosis, and a few sensitive single wavelengths have been chosen for EPD and fault detection.[1] However, One of the problem is blurred viewport due to the by-product, and the other is reduced optical signal intensity caused by complex materials on the wafer.[2] In this work, we adopted the multivariate analysis techniques such as modified K-means cluster analysis and PCA to OES for enhancing the sensitiviti of plasma diagnosis.

2. 본론

K-means cluster analysis is the method of partitioning a set of objects into subsets for EPD because the collected data are separated into two groups: before endpoint and after endpoint. Endpoint can be detected by using a equation of cluster validity evaluation. Principal component analysis (PCA) is a technique for deriving a reduced set of orthogonal linear projections of a single collection of correlated variables,[3] and it is modified for real-time processes. Therefore, an analysis of a large number of variations is reduced to a smaller transformed set.

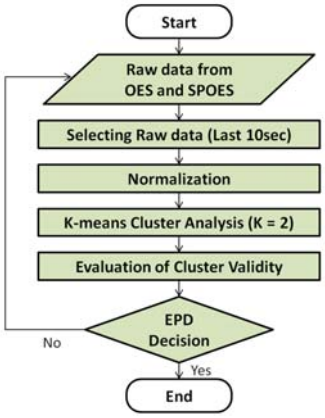

Figure 1. Real-time EPD algorithm by modified K-means Cluster Analysis

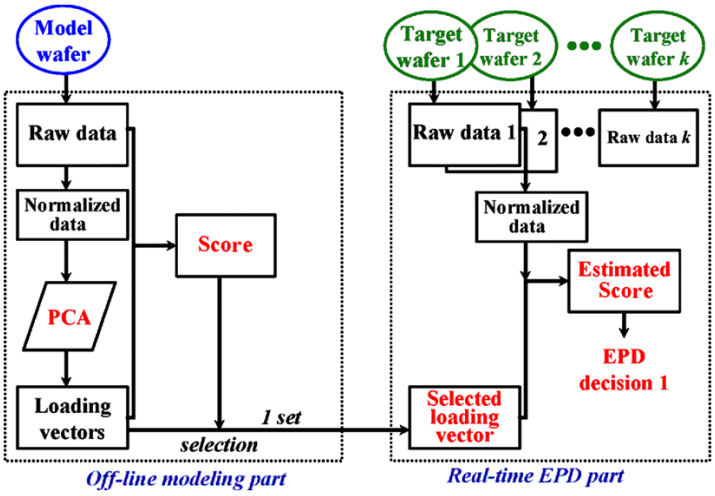

Figure 2. Real-time EPD algorithm with the modified PCA

A 13.56 MHz RF source power and a 12.56 MHz RF bias power was applied for a 100 mm wafer. The following feed gases were supplied: 40 sccm of CF_4, 10 sccm of O_2, and 40 sccm of Ar. The chamber was operated at 50 mTorr with

250 W of source power and 250 W of bias power. Additionaly, intentional fault is generated from 10.0 to 1.0 %: source power, bias power, and feed gasese flow rate. SiNx coupon wafers were prepared, and the coupon wafers were placed on the blanket Si wafer and etched. The area of the coupon wafers was varied from 2.0 to 1.0 % relative to a 100 mm wafer. For plasma monitoring, the optical emission spectroscopy (OES) was installed.

3. 결론

The purpose of this study was to enhance the sensitivity of real-time endpoint detection (EPD) and fault detection using the newly proposed method based on the optical emission spectroscopy (OES) with modified K-means cluster analysis and principal component analysis (PCA). The sensitivity for plasma diagnosis is drastically improved. Therefore, multivariate analysis techniques can be applied for improving sensitivity of OES.

참고문헌

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