New Equipment Monitoring Method Using Impedance Measurements– Yosuke Inoue

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Abstract

We have developed new equipment monitoring method using impedance measurements for reducing downtime to investigate root-cause. In this paper, at first we explain the outline of our method, and then report the results that we confirmed its effectiveness in the investigation.

1. Introduction

Recently, We monitor the equipment state in real time for reducing wafer scrap by using various methods. We continue the activity to detect fault quickly by monitoring vibration of wafer transferring system, and chamber pressure, gas flow, RF power and impedance of process chamber. But even if fault can be detected quickly, downtime of equipment increases due to investigation of the root-cause of its fault. Because it is difficult to find the root-cause in the case of using conventional method such as impedance monitor. Therefore we have developed new equipment monitoring method.

2. Experimental

2-1. Fundamental Evaluation

Fig. 1 shows outline of our method. First we measure a frequency response of equipment impedance as shown in Fig.1(b). Next we calculate time response by using inverse Fourier transform as shown in Fig.1(c). With one measurement, we can find many kinds of faults such as abnormal discharge, connector trouble, and cable disconnection from the time response. We made two kinds of strip-line that has simple structure in order to understand fundamental characteristics. Fig. 2 shows each strip-line. The above one is narrow strip-line, and the below one is broad strip-line. Each graph below the figure is ideal impedance profile for time axis. We evaluated whether we can get ideal profile with our method.

2-2. Evaluation of Mass Production Equipment

We evaluated plasma CVD chamber with/without plasma voltage failure to identify its root-cause by our method. Fig. 3 shows the diagram of our method in plasma CVD chamber. We removed matching box from RF line, and connected a monitoring tool to measure.

3. Results

3-1. Fundamental Evaluation

Fig. 4 shows the result of measurement. In the case of narrow strip-line, impedance is large in center section. On the other hand in the case of broad strip-line is small almost such like ideal impedance profile for time axis shown in Fig.2. Therefore we confirmed that we are able to monitor impedance profile corresponding to the structure of RF line.

3-2. Evaluation of Mass Production Equipment

Fig. 5 shows one of the examples of impedance profile for time axis in plasma CVD for mass production. Zero point of horizontal axis shows the point of connecting monitoring tool. In the figure, each part of waveform corresponds to RF plate, top plate section, gas plate, and heater section through the electrode gap. We can get every part's data at once. On this figure we compare the difference of impedance from the previous section on each section. Fig.6 shows the difference of impedance of heater section. The left bar is the difference of impedance in chamber without failure, and center one is that in chamber with failure. The impedance of chamber with failure is higher than that of chamber without failure. It indicates that heater section had electric continuity defect. Therefore we replaced the parts of heater section which consist of heater and bellows. The right bar in Fig.6 is the difference of impedance after changing. The impedance became almost as same as the one of chamber without failure. And the failure disappeared. We consider that the root-cause of failure was electric continuity defect due to much deposition between heater and bellows. Therefore, we confirmed that our new method is effective to identify the root-cause in mass production equipment quickly.

4. Conclusion

We have developed new monitoring method for reducing downtime to investigate root-cause.
In the future, we increase the productivity of equipment by long-term monitoring.

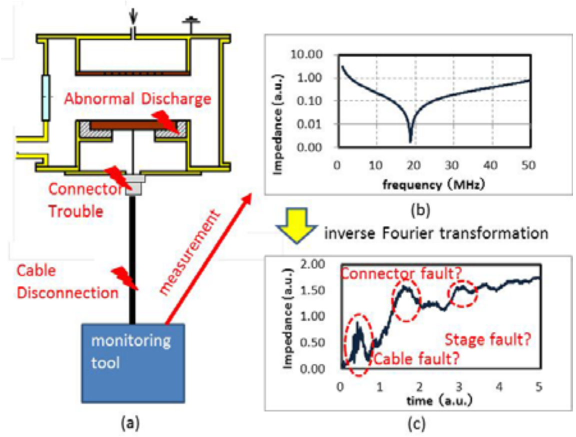

Fig.1. Outline of our new equipment monitoring method

(a) measurement system

(b) frequency response of equipment impedance

(c) time response of impedance

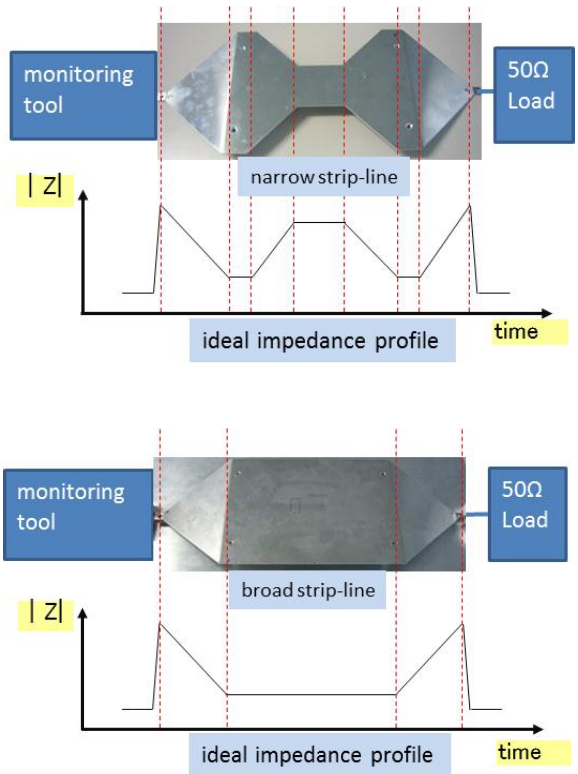

Fig.2. The above one is narrow strip-line, and the below one is broad strip-line.

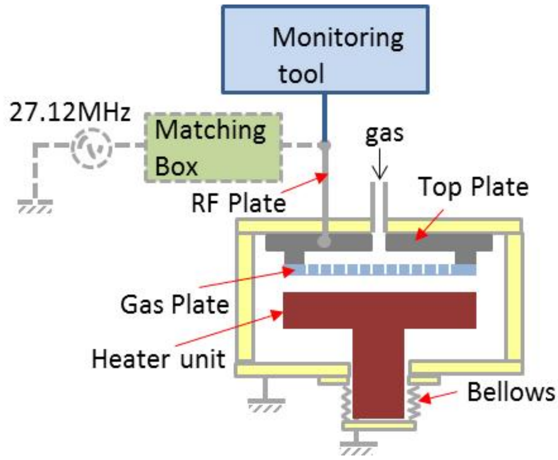

Fig.3. The diagram of our method in plasma CVD chamber

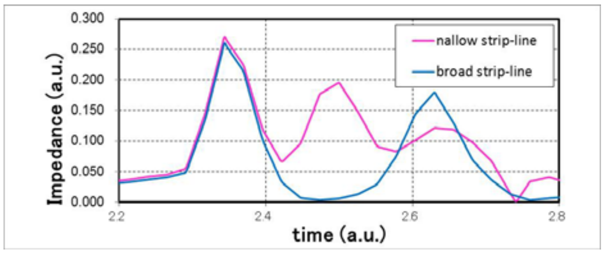

Fig.4. The result of strip-line measurement

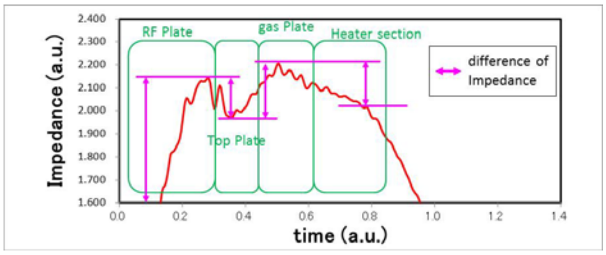

Fig.5. one of the examples of impedance profile for time axis in plasma CVD for mass production

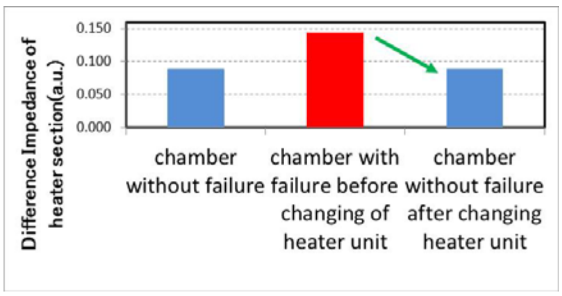

Fig.6. The difference of impedance of heater section