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PARTICLE CONTAMINATION DETECTION IN PLASMA ETCHING PROCESS USING ARTIFICIAL NEURAL NETWORK

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ABSTRACT

Particle contamination on wafer during fabrication process has become major issue in semiconductor manufacturing. Particles on wafer can cause the circuit to malfunction affecting manufacturing cost and productivity. Currently, detection of particles is conducted after the etching process was completed. Therefore, developing a system where an early particles detection is crucial. In this study, a method for particle contamination detection in plasma etching process using Artificial Neural Network (ANN) is proposed. The proposed method comprised of four steps. First, data collection from Statistical Process Control (SPC) and Advanced Process Control (APC), Infineon Technology, Kulim. Three collected datasets are 45i01, 45i08 and 45i10. Secondly, collected datasets is pre-processed to remove missing values and unwanted attributes. Thirdly, feature selection is used to select the most relevant features that correlated with the number of particles contamination. Three feature selection techniques are used which are Minimum Redundancy Maximum Relevance (mRMR), Least-Square Feature Selection (LSFS) and Maximum Likelihood Feature Selection (MLFS). Finally, datasets with the selected features together with datasets without features selected are used as inputs for training and testing ANN in particles contamination detection. In this work, multilayer perceptron (MLP) network is used for ANN model. The datasets with and without feature selection is used to evaluate the performance of MLP network. Simulation results indicated that CNT_WF_V and ESC_RF_HOUR parameters are the most relevant features correlating to particle contamination as both features were voted by the three feature selection methods. Simulation results also showed that 45i01 and 45i10 without feature selection method have lowest error and maximum R^2 where 45i01 have 176.59 and 13.29 errors and R^2 is 0.84. As for 45i10, errors are 165.77 and 12.88 and R^2 is 0.82. 45i08 with feature selection method using MLFS have 291.51 and 17.07 errors and 0.75 R^2.

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CHAPTER 1
INTRODUCTION

1.1 BACKGROUND OF STUDY

Nowadays, a lots of electronic products and services have been produced and used by peoples. Most of the products produced are small in sizes. Increasing demands from consumers for faster, smaller, and cheaper electronic products gradually shrinking its geometries [1, 2]. While this development is beneficial to consumers, problems also arose to manufacturers in semiconductor industries which is particles contamination on wafers during plasma etching process. The generated particles on wafers decreased production yield and lowered machine operation efficiency [2]. It is for these reasons that the semiconductor manufacturers are trying to make an effort to eliminate or reduce the particles generation's problem.

In order to overcome the particles contamination problem, Artificial Neural Network (ANN) is proposed in this project. The ANN will be used for early detection of particles generation on wafers during plasma etching process. The wafer fabrication can be stop at the earlier stage if the detection of contamination is high. It can gives a lot of advantages for semiconductor manufacturers such as higher yields and more cost-efficient.

In order to perform the detection, the raw dataset is obtained from Statistical Process Control (SPC) and Advanced Process Control (APC) in Infineon Technology, Kulim. After obtaining raw data, pre-processing is the next step. Then, feature selection method is implemented to select the most relevant features extracted from SPC and APC that correlated with the number of particles contamination on wafers. Three feature selection techniques are used which are Minimum Redundancy Maximum Relevance (mRMR), Least-Square Feature Selection (LSFS) and Maximum Likelihood Feature Selection (MLFS). Finally, datasets with the selected features together with datasets without features selected are used as an inputs for training and testing ANN in particles contamination detection.