ID DM-P-031

Study of adaptive model predictive control algorithm for efficient control of semiconductor process

Sang-Hoon Park, Dong-Il Kim, Baek, J.-G, Sung-Shick Kim
hoon@korea.ac.kr, dong22000@korea.ac.kr, jungeol@korea.ac.kr, sungskim@korea.ac.kr
BISTEL Inc
2F, Jeongpung Bldg., 1341-3, Seocho-dong, Seocho-gu, Seoul, Korea 137-070
Phone: +82 -2-597-0911 Fax: +82-2-597-0901

The model predictive controller (MPC) has been shown to improve run-to-run process control for non-linear processes. This paper remark the inability of the MPC Algorithms to weak in the face of process disturbances. This issue is important to the success of the MPC model in nano-process where process may be poorly approximated with the process have large disturbances. This issue worked out by using exponentially weighted moving average (EWMA). The MPC is dynamically updated using a EWMA of the biases in the prediction step. In this paper, the proposed algorithm shows that correcting prediction value improves on the MPC model to become stable. Simulation shows that proposed algorithm provides more effective control than MPC algorithms. In addition, proposed algorithm is robust in the face of model error and noise. Proposed algorithm allows the basic property of the MPC model, improved control with process noise.

In this paper, adaptive model based process control (AMPC) system is proposed. The AMPC system is designed for the precision processes that occurring random disturbances (drift/shift) continuously. The two main components of the system are prediction module for metrology prediction and adjusting prediction value for update process disturbances run-by-run. The first module is attended on model based process control (MPC) procedure. And the second module is measure amount of process disturbance like drift/shift. The proposed control system is developed correcting make the prediction value by predictor in MPC procedure. To verifying the proposed control system, AMPC was compared with exponentially weighted moving average (EWMA) control, MPC in even circumstances.

Semiconductor process is very sophisticated process. The process is large influenced by little alteration in element that engaged the process. Most of semiconductor process, random process disturbances (drift/shift) continuously occurred. There are too many factors causes the process disturbances like state of equipments, temperature, atmospheric pressure, oscillation, etc. In nano-process, many factors even though changed little, can big impact to the process result. So the control system what can reflect process state is necessary to control nano-process well.

AMPC is proposed to applying prediction model for adjusting random disturbances. [Figure 1] shows AMPC structure. There are four major modules in AMPC. First module is calculating initial recipe. Second module is predicting the metrology value using prediction algorithms like artificial neural network (ANN), partial least squares(PLS), support vector machine regression(SVMr), ETC. Third module is adjusting predicted value spell over the process disturbances. Finally fourth procedure is calculating optimal recipe using adjusted predicted value. The difference between MPC and AMPC is adjusting prediction value using EWMA.

In this paper, simulation result shows AMPC is robust in the face of random process disturbances. Control system for improving the performance of the semiconductor process control by adjusting prediction value into the overall control scheme has been proposed in this paper. By generating a pseudo lot that reflects the current process condition, simulation result of the current process condition is distinguishable improved. Using EWMA, the performance of the control model is enhanced. Simulation of the proposed control system shows promising result.

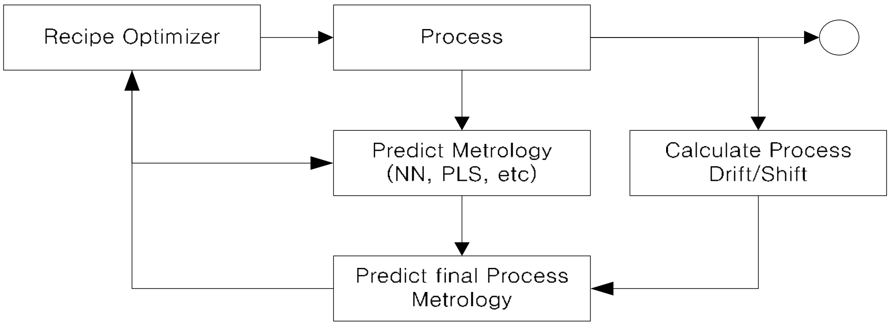
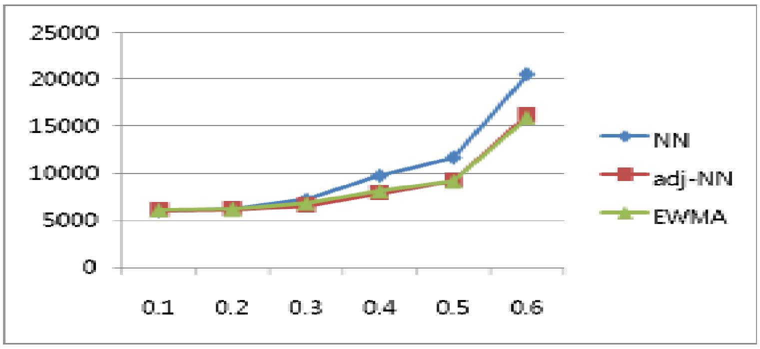
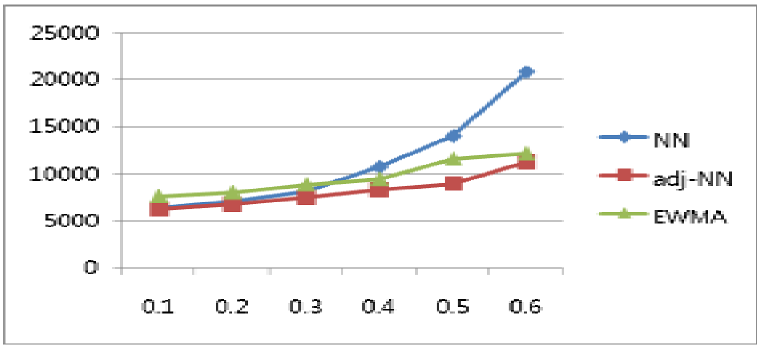


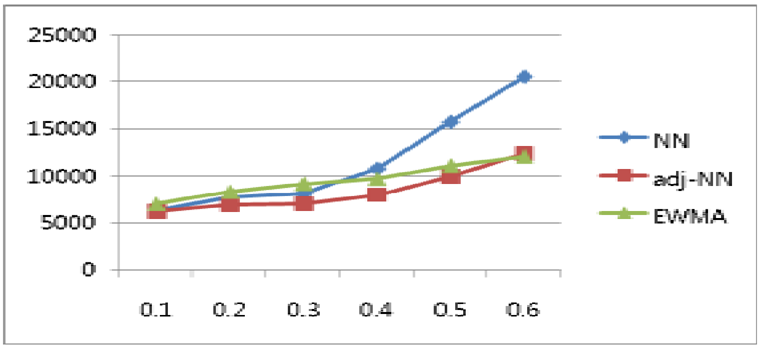
Figure 1. AMPC Structure



(a) Linear process model



(b) Half-linear process model



(c) Non-linear process model

Figure2. Simulation results