摘要

製程控制在製造系統中扮演極為重要之角色，其目的在於連續性的回饋製程干擾項以使得量測輸出值接近目標值。近年，在半導體製造系統中，指數權重移動平均（EWMA）控制器已被證實是一有效之控制方法。然而，EWMA 控制器之有效性決定於其參數的選擇。也即是，錯誤的設定調整參數值會增加控制後輸出值之變異。

對於選擇 EWMA 參數之議題方面，許多相關的研究僅止於搜尋其在靜態方面之最佳參數解。但是在實際之製程中，環境往往是動態而非靜態。因此，為了要提升在動態環境中 EWMA 控制器之績效，發展具線上動態調整之 EWMA 控制器是一重要的議題。

基于上述，此研究致力於發展動態性調整之 EWMA 控制器並評估其有效性。本研究之主要目的為：

1. 發展以類神經網路為基礎之適應性單一 EWMA 控制器；結果顯示，以類神經網路為基礎之適應性方法比 Patel 與 Jenkins (2000)所提之適應性方法更為有效；
2. 發展一雙層 EWMA 控制器之時變調整方法，目前相關議題之研究尚屬少見。結果顯示，以所提之時變調整策略調整雙層 EWMA 控制器比起 Del Castillo (1999)所建議之損益平衡（trade-off）調整方式擁有較佳之績效表現。進一步地，我們也將發展動態性調整雙層 EWMA 控制器。經由模擬驗證，所建議之控制器能及時調整雙層 EWMA 控制參數以回饋因干擾模式參數的變動而對製程所造成的影響。

線上動態調整 EWMA 控制器，可以減少人員操作調整之成本。經由數值分析，本研究所提之動態調整方法比起先前相關文獻上的方法，在績效表現上要來的好且容易實行。因此，當製程中有批次控制之相關議題時，使用本研究所提之動態調整方法將可提升輸出值之績效。

關鍵詞：指數權重移動平均、類神經網路、損益平衡、偏差導向、變異導向。

ABSTRACT

Process control plays an important role in a manufacturing system. The objective of process control is to continuously compensate for disturbance in order to keep measures of quality as nearly as possible equal to the target values for indefinite periods of time. In recent years, the exponentially weighted moving average (EWMA) controllers have been proven to be effective algorithms to control the semiconductor manufacturing system. The performance of the EWMA controlled process is based on setting the correct EWMA weight parameters. That is, an incorrect choosing of the EWMA weight parameters will have the opposite effect on the controlled process output.

Most related researches have focused on analyzing the optimal EWMA gains in the static condition. Unfortunately, a process environment is usually dynamic in a real manufacturing world. In order to achieve a better performance in the dynamic system, developing a method of on-line tuning of the EWMA controller parameters is an important issue.

As mentioned above, this study aims to develop dynamic tuning methods for EWMA controllers. The performance of these methods will be evaluated. The main objectives of this study are:

1. Develop a neural network (NN) based adaptive algorithm for the single EWMA controller. The proposed controller was shown to be effective than the Patel-Jenkins (2000) adaptive algorithm.
2. Develop a time-varying weights tuning strategy for the double-EWMA controller. The relevant research has seldom been mentioned before. The proposed tuning strategy was shown to possess better performance than the trade-off tuning method that was proposed by Del Castillo (1999). Furthermore, a dynamic tuning

double EWMA controller under wear-out process will also be developed. The proposed controller was shown to be able to provide the capability to dynamically adjust control parameters in response to drifting disturbance changes.

The proposed dynamical controllers could update the EWMA gains automatically, which would reduce the needs for operators to tune recipes in the process. Numerical results showed that proposed methodologies possesses superior controlled output performances compared to the previous works and are easy to implement. It is recommended that when data from processing equipments or tools are available, the proposed dynamical EWMA controllers should be used to perform the process control.

Keywords: EWMA, Neural Network, Trade-Off, All-Bias, All-Variance.