

IN-SITU ELECTROCHEMICAL SENSOR FOR EARLY DETECTION OF PLATING PROBLEMS IN COPPER DAMASCENE PROCESS

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Reliability and robustness of all processes in semiconductor fabrication are necessary for high-yield manufacturing of integrated circuits. During the past few years, electrodeposition of copper has established its position as a leading process for interconnect wiring on silicon wafers. Electroplating traditionally employed for less demanding applications, has entered the new field with higher standards and expectations than one currently available. A straightforward transfer of traditionally available monitoring techniques seems to be inadequate to meet these new challenges.

A system was developed utilizing a novel approach that combines advanced electroanalytical methods with various statistical data analysis techniques based on chemometric factor analysis. All measurements and calculations were performed using instrumentation and software custom developed for this application.

The electroanalytical techniques employed including DC- and AC-voltammetry [1,2] were designed to provide a response strongly affected by the presence of foreign contaminants, accumulated degradation products, out-of-target concentrations of bath constituents and out-of-target physical conditions of the plating process (i.e. temperature). The shape differences between deformed and training set voltammograms are quantified using various outlier-detection chemometric techniques including PCA [3], MD/PCA, MD/PCA/R [4], SIMCA and F^S -ratio [5]. These differences are correlated with the plating performance of the bath and corresponding automatic warnings are established.

The system was proven to be effective for a controlled bleed-and-feed procedure (Figure 1). Employing a quantitative method to control bleed-and-feed can eliminate a guessing factor from this procedure, and subsequently can be easily translated into direct cost reduction.

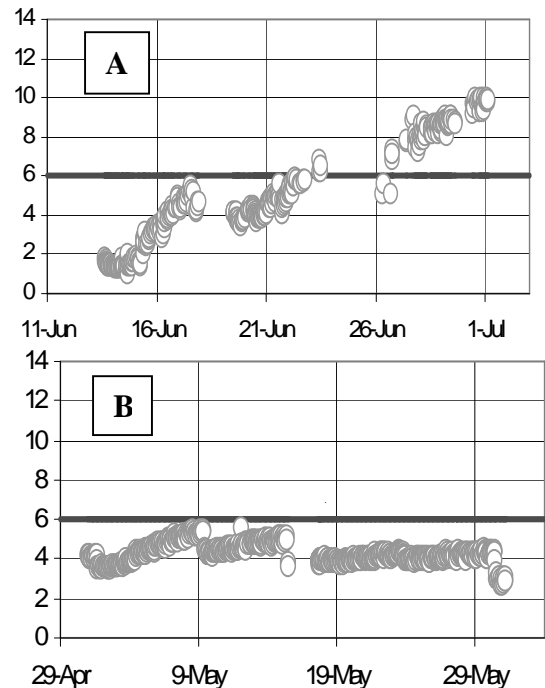


Fig.1. MD values calculated for voltammetric responses obtained in (A) passive (no bleed-and-feed) and (B) active (bleed-and-feed) copper plating systems.

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