Real-time Multivariate Model Predictive Control of Plasma Etch Process

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Plasma etch process is the most critical step in semiconductor manufacturing since it determines a line width which have a decisive effect on the performance of devices. It has been controlled almost exclusively in open loop mode using recipe, which are expressed in terms of RF power, chamber pressure, gas flow rates, and so on. However, even identical chambers under the same recipe may produce different results due to real-time disturbances like wall seasoning and actuator drift. Chamber matching, which has been used as a temporary expedient, entails iterative costly run-to-run analysis of metrics such as etch depth, anisotropy, uniformity, and selectivity. Furthermore, the problem occurred in real-time still remains unsolved. To solve this problem, we found key plasma variables that can be measured in real-time by non-intrusive sensor and express them in terms of the recipe. Finally, real-time multivariate model predictive control of electron density and electron temperature using RF power and chamber pressure has been implemented on a capacitively coupled Ar/SF_6 plasma.