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A Study of the CMP(Chemical Mechanical Process) Simulation using FEM(Finite Element Method) and the Run-to-Run Control Algorithm

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In the paper, we propose the method to simulate CMP(chemical mechanical process) using FEM(finite element method) and the algorithm to control non-linear process by using the simulation result. In former studies, the linear model based the Monte-Carlo simulation method is widely used for verifying and validating performance of the run-to-run algorithms. In the paper, the FEM simulation method is applied to make the process model more similar to the actual system in the aspect of physical and chemical process. The physical and chemical processes are not always explained by the linear model. Terms of the model are not always consisted by linear terms. and also can be said that the actual system does not always explained by the linear model. If the model of control system is linear but actual system is non-linear, the control error will be increased. so it is required to develop non-linear run-to-run control algorithm.

In the paper, the Preston's equation is used for simulating CMP by FEM. former studies about CMP simulation show that the Preston's equation can describe CMP well. In addition, the aging equation of polishing pad is developed to apply the issue of aging pad to simulation.

The non-linear model of MIMO(multiple input multiple output) system is needed to apply the run-to-run control algorithm to the CMP. The proposed non-linear run-to-run control algorithm has two characteristics. One is the method of recursive updating the model using the EKF(extended Kalman filter) algorithm. The other is that the Levenberg-Marquardt algorithm is applied to find control value from updated non-linear model.

In the paper, it shows some simulation results that the proposed run-to-run control algorithm is better than former run-to-run control algorithms (MA, EWMA, etc.).

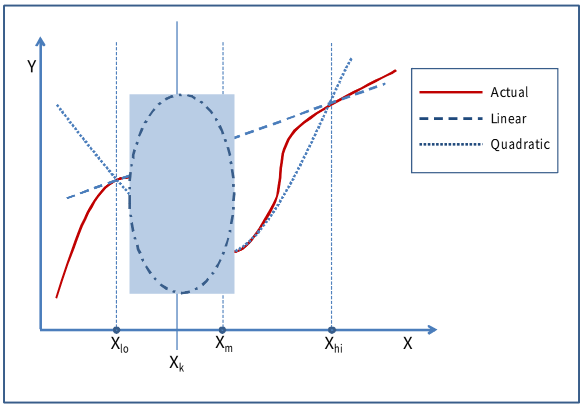

fig 1. amount of potential error a of the linear model and amount of potential error b of the quadratic model

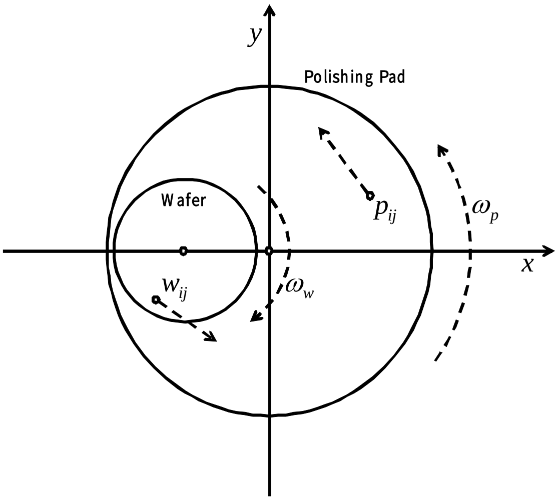

fig 2. FEM relation between wafer and polishing pad

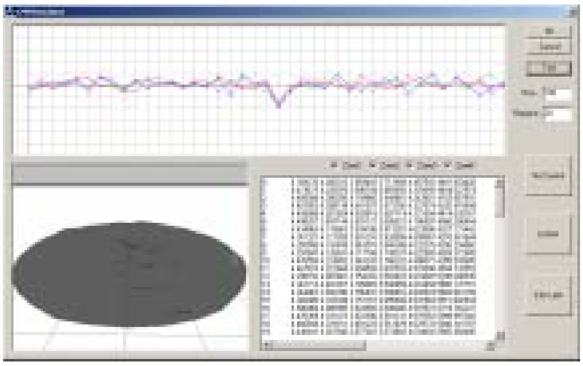

fig 3. Simulation Program

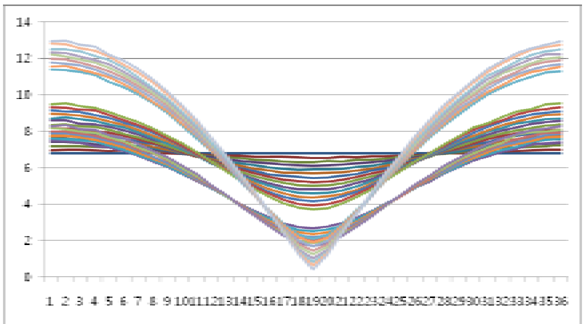

fig 4. non-linearity of removal rate within a wafer

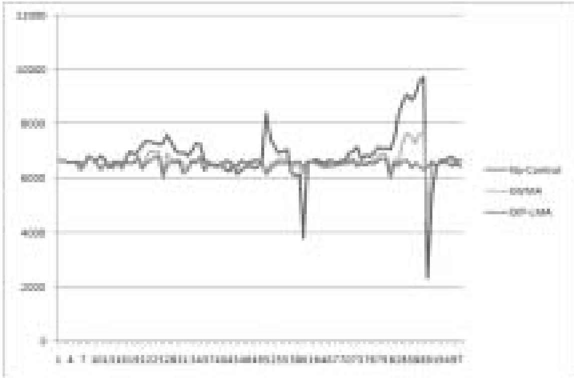

fig 5. simulation result of average thickness by r2r control algorithm

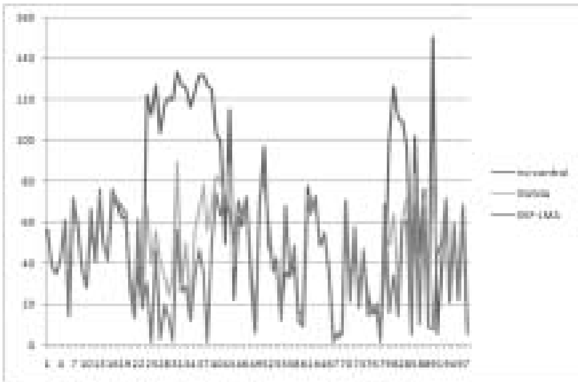

fig 6. simulation result of uniformity by r2r control algorithm