Proceedings of the 10th World Congress on Mechanical, Chemical, and Material Engineering (MCM'24)
Barcelona, Spain - August 22-24, 2024
Paper No. ICMIE 114
DOI: 10.11159/icmie24.114

Grinding Parameter Designs For Wafer Grinding With Predesignated Wafer Profiles

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Extended Abstract

The wafer profile plays an important role in determining the wafer quality in semiconductor industry. The wafer quality typically quantified in terms of bow, warp, total thickness variation (TTV) [1] and roughness is strongly affected by the process and setup parameters in a grinding process. The process parameters characterized by the grinding dyanmices including the feed rate, the rotational speeds of grinding wheel and chuck table affect the wafer surface rougness. The setup parameters represented by the relative position of the grinding wheel and chuck table, consisting of the tilt angle of the chuck table, the grinding wheel size, and the distance between the grinding wheel and the chuck table determine the resulting wafer profile, such as TTV. On the other hand, the wafer bow, and warp are influenced not only by the setup parameters but also the residual stress during the process.

In this study, a novel methodology in determining optimal grinding parameters for wafer grinding to produce predesignated wafer profile was proposed. The approach is a typical inverse problem which starts with the effects and then calculates the causes. The methodology compromises two phases. In the first phase, a three-dimensional mathematical model which simulates the abrasive trajectories caused by the grit of grinding wheel onto the wafer was created based on homogenous coordinate transformation. This technique was also used in previous research [2, 3].The abrasive trajectories become be the cross-hatch grinding marks on the wafer surface. The resulting wafer profile after the grinding process are superimposed by those abrasive trajectories and can be predicted accurately after experimental validations. The tilt angles in [4, 5] were found to be the main factor of wafer geometry quality in terms of TTV. In addition, simulations revealed that the main parameters influencing wafer geometry are dominated by the relative position of the grinding wheel and chuck table, including offset distance. With this wafer ginding model, various wafer profiles can be generated by superimposing all the abrasive trajectories while adjusting the tilt angles and offsets, and those simulations serve as training data for the second phase of the proposed methodology. In the second phase, a wafer profile is defined firstly according to the predesignated wafer thickness variation. Then the optimal grinding parameters to produce this predesignated wafer profile based on supervised machine learning was developed with the training data from numerical simulations according to the mathematical model developed in the first Phase. In particular, the labelled data used in the machine learning was created from simulations of the validated mathematical model instead of time-consuming experiments. Results show that the wafer with predesignated wafer profiles can be realized more systematically, enhancing better wafer production efficiency and quality.

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