Model-based process control for precision CNC machining for space optical materials

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During fabrication process for the large space optical surfaces, the traditional bound abrasive grinding with bronze bond cupped diamond wheel tools leaves the machine marks and the subsurface damage to be removed by subsequent loose abrasive lapping. We explored a new grinding technique for efficient quantitative control of precision CNC grinding for space optics materials such as Zerodur. The facility used is a NANOFORM-600 diamond turning machine with a custom grinding module and a range of resin bond diamond tools. The machining parameters such as grit number, tool rotation speed, work-piece rotation speed, depth of cut and feed rate were altered while grinding the work-piece surfaces of 20-100 mm in diameter. The input grinding variables and the resulting surface quality data were used to build grinding prediction models using empirical and multi-variable regression analysis methods. The effectiveness of the grinding prediction model was then examined by running a series of precision CNC grinding operation with a set of controlled input variables and predicted output surface quality indicators. The experiment details, the results and implications are presented.