Model based process control for efficient fabrication of large astronomical mirrors

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Optics fabrication process includes bound abrasive grinding, loose abrasive lapping, polishing and figuring. During fabrication process for the large astronomical mirrors, the traditional bound abrasive grinding with bronze bond cupped diamond wheel leaves the machine marks of about 20 um rms in height and the subsurface damage of about 1 um rms in height to be removed by subsequent loose abrasive lapping.

We explores an efficient quantitative control of precision CNC grinding that can reduce the machine marks and subsurface damage down to sub-microns in scale. The facility used is a NANOFORM-600 diamond turning machine. 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 to the large ground based telescope project currently being discussed among Korean astronomers are presented.