SUMMARY OF Ph.D. DISSERTATION

School Integrated Design Engineering	Student Identification Number	SURNAME, First name INOUE, Shigeru

Title

Study on Advanced Components for the Performance Enhancement of CNC Tool Grinding Machines

Abstract: According to the increase of demands for machining accuracy, the performance improvement of cutting tools is strongly expected. On the other hand, the remarkable improvement of efficiency in tool grinding process must be attained in order to counter the low cost tool supply from Asian countries and to machine the new tool materials (DIA, cBN) with difficult to machine characteristics. The worldwide trend in environmental protection cannot be ignored in the tool grinding process, and the decrease of coolant consumed in grinding process and the re-grinding of used tools become the important issues in tool grinding. The objective of this research is to develop new functions in tool grinding process to facilitate the design of environmentally friendly CNC tool grinding machines capable of efficient and accurate grinding of a diverse range of cutting tools.

Chapter 1 explains the CNC tool grinding machine and the background of this research.

Chapter 2 consists of the performance tests of the high speed grinding on standard tools. The high speed grinding method using HSK tool interface of two-surface constraint is applied to the flute groove grinding of tools, and the results are compared with the grinding tests using BT tool interface. The HSK tool interface is also utilized for manufacturing ball end mills, and the effectiveness is evaluated.

Chapter 3 shows the application of EDM(electrical discharge machining) to a CNC tool grinding machine. Normally, PCD(polycrystalline diamond) tools are ground by diamond wheels, so the material removal rate during grinding is very low, with significant abrasion of the diamond wheel. In order to minimize the amount of material removal during fine grinding, the conditions of electrical discharge machining are evaluated. Furthermore, EDM and grinding process are applied to the manufacturing of PCD drills and ball end mills, and the effectiveness of applied process is analyzed.

Chapter 4 consists of the effort to suppress the thermal expansion of the grinding spindle. The reduction of the thermal expansion of the grinding spindle is required for the grinding of high precision tools. In order to clarify the thermal deformation characteristics, the new spindle using IPM(interior permanent magnet) motor is proposed. The performance of the developed spindle with IPM motor are experimentally evaluated. The results are compared with the conventional type grinding spindle using induction motor.

Chapter 5 describes the CNC tool grinding without coolant. Dry, cooling-air and cooling-air + MQL(Minimal quantity lubrication) grinding are applied, and the results of the grinding tests are compared with the conventional grinding where oil-based coolant is used. Furthermore, the cutting test is executed under the same cutting conditions using the manufactured end mills which is ground by four different kind of grinding methods, and the cutting performance is evaluated.

Chapter 6 discusses the application of automatic positioning to the re-grinding of small tools with a diameter of ϕ1mm or less. A non-contact type optical sensor is used, and the least-squares method is applied to obtain the phase angle that provided the maximum tool diameter from the measured data. Furthermore, actual re-grinding test is performed for end mills between ϕ0.2mm and ϕ1mm in diameter, and the effectiveness is evaluated.

Chapter 7 summarize the results of this research and taking a look at future prospects.