The Japan Society for Precision Engineering

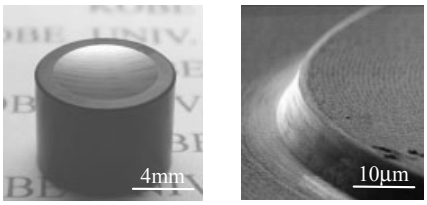
Introduction of Awards for 2007

1. JSPE YOUNG RESEARCHER AWARD

Yuji YAMAMOTO

Precision Grinding of Micro Fresnel Lens Molding Die (2nd Report) -Precision Truing of Micro Grinding Wheel with Sharp Edge by Molybdenum Truer and Accuracy Improvement in Fresnel Surface Grinding-

Demand for a micro Fresnel glass lenses is increasing, especially for use in DVD pick-ups and dark field systems for automobiles. Ultra-precision grinding technology of ceramic molds and dies has become a core technology, by virtue of its high accuracy. The authors have successfully developed a simultaneous 2-axes (Y, Z) controlled grinding method, and their study has clarified that an ultra-precision micro Fresnel shape can be ground by means of a diamond wheel with a sharp edge. In this paper, a new truing method with rare metal truer is proposed and the effects of the molybdenum truer are tested. Finally, with the developed truing system, an aspherical mold of Fresnel glass lens for infrared DOE is ground in order to evaluate grinding performance.



(a) Appearance (b) SEM image

Fig. 1 Infrared DOE modeling die

Sachio KOBAYASHI

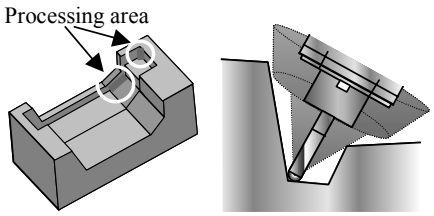
Generation of Curves by Controlling Curvature Variations Based on Discrete Curves

Curvature is an important geometrical property for curve generation in engineering applications. Many methods for controling the curvature distribution of curves have already been proposed, but most of them are for planar curves. This research proposes a new scheme for controlling curvature distribution of planar and space curves based on discrete curves. For application to practical CAD/CAM, a G2 curve consisting of quintic Bezier curve segments has been generated by the energy minimization method. The curvature distribution of a curve generated by means of the method of this paper shows smooth change throughout the curve.

Kuninori MORIMOTO

Study on Computer-Aided Process Planning of Mold Part Machining -An Algorithm for Determining the Optimal Cutting Direction for Deep Mold Machining-

Large molds with very deep shape are widely used in producing bumpers and inner panels of automobiles. Machining of such deep molds is often accomplished by 3-axis milling with inclined cutters. In this paper, we propose a new algorithm for determining the optimal cutting direction in such inclined machining. We introduce a concept of accessible cone as a measure for evaluating stability and safety. The cutting direction can be derived by rendering the silhouette picture of the mold. This computation can be accelerated by use of a graphics processing unit (GPU), which is now equipped in most PCs. A proposed algorithm is implemented, and an experimental process planning assistance program using this technology is demonstrated.



(a) Processing area (b) Computed accessible cone

Fig. 2 Processing area and accessible cone for the area

Chengri CUI

Development of Measuring Method for Positioning Accuracy of Tilting Axes in Five-axis Machining Centers -Development of Clinometer using a Rotary Encoder and a Level-

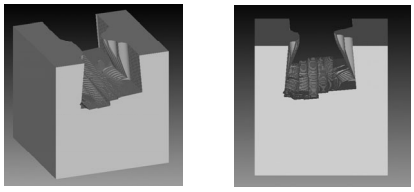
This paper describes the measuring methods for positioning accuracy of tilting axes in five-axis controlled machining centers with a tilting rotary table. The top surface of the tilting rotary table is generally positioned higher than the tilting axis. In this case, the only measuring method is a manually operated clinometer. Thus, a clinometer consisting of a precision rotary encoder and a bubble level was developed. Furthermore, in order to eliminate manual operation, an electronic level with high resolution was employed instead of a bubble level. Ball bar equipment was also applied to measure the angular

positioning accuracy of the tilting rotary table, as the ball bar equipment can measure the angular displacement continuously.

Chihiro HIRANO

Development of Rough Cutting Method with Plunge Milling Using 5-axis Control Machine Tool

This paper deals with the rough cutting method using a 5-axis control machine tool to machine complicated shapes efficiently, which requires inclination of the cutting tool. The conventional contour milling with 3-axis control is not always efficient, because several set-up changes are required. The study proposes a new rough cutting method for 5-axis control machining. In order to achieve the method, the tool path must be generated in consideration of the tool interference with not only the target shape but also the remaining parts. Therefore, the study developed the tool path generation method by expanding the method which uses the 2-dimensional configuration space technique. Finally, the developed method is implemented with the original CAM software. As a result, the experiment shows that the system enables the rough cutting of complicated shapes with 5-axis control with only one set-up operation.



(a) Over view (b) Front view

Fig. 3 Machining simulation result

2. JSPE TAKAGI AWARD

Development of milling-combined laser metal sintering method -Combination of laser-assisted metal sintering method and the milling in one machine-

Satoshi ABE, Yoshikazu HIGASHI, Hirohiko TOGEYAMA, Isao FUWA, Norio YOSHIDA

(Panasonic Electric Works Co., Ltd.)

An innovative system of milling-combined laser metal sintering is developed, combining laser-assisted metal sintering and a milling process. In this process, the periphery of the sintered layers is machined by end mill in several sintering steps.

To obtain accurate dimensions and a smooth surface, the relation between energy density of the laser and density of the sintering surface is evaluated. Within the range of energy densities greater than 4.1J/mm^2, approximately 100% density is obtained. Also, the milling condition is evaluated for the surface roughness. As the results of a sample processed by the developed Milling-Combined Laser Metal Sintering system, dimensional accuracy of +/-0.03 mm and surface roughness of Rz20 micrometer are obtained. Additionally, the results confirmed that mold manufacturing time is reduced by half as compared with a conventional machining process.

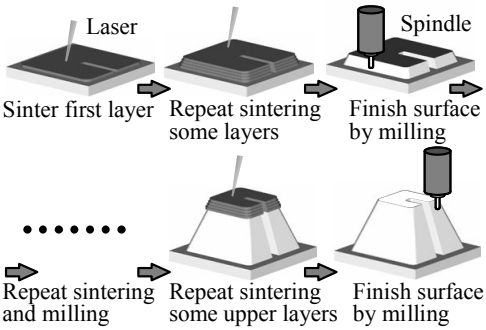


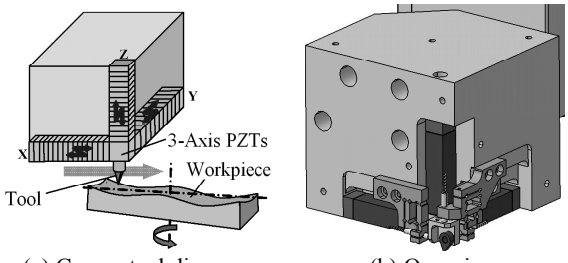
Fig. 4 Process image of milling-combined laser metal sintering

Development of a Three Axis controlled Fast Tool Servo for Ultra Precision Machining (1st Report) -Development of 3-axis FTS Unit and evaluation of its characteristics-

Toshihiko WADA, Masayuki TAKAHASHI, Toshimichi MORIWAKI, Keiichi NAKAMOTO

(Panasonic Corporation)

This paper presents a newly developed 3-axis controlled Fast Tool Servo (FTS) machining system for ultraprecision machining, which is driven in synchronization with rotation of the workpiece fixed on the rotary table. With the FTS unit, an arbitrary cutter path is realized in the space by controlling the motions of three piezoelectric actuators arranged along three orthogonal axes. Motion signals obtained with three capacitive-type proximeters are fed back to the controlling computer in order to guarantee the required tool paths. A mold with a cylindrical surface was machined with the developed system, and the obtained form accuracy was 0.22 um P-V.



(a) Conceptual diagram (b) Overview

Fig. 5 Developed 3-axis FTS unit