The Japan Society for Precision Engineering

Introduction of Awards for 2007

1. JSPE BEST PAPER AWARD

Study on High Efficiency Machining with Reaction-Free Shuttle Unit

Kenzo EBIHARA, Akira YAMAMOTO, Tomohiko KAWAI, Yoshimi TAKEUCHI

This paper introduces a Shuttle Unit, which can be attached to an ultra-precision milling machine, for high-speed machining of micro-grooves and micro-dimples. The unique reaction-free structure compensates for the Shuttle's reaction force. This unit can machine 3 grooves persecond, or 200,000 dimples in 4.5 minutes.

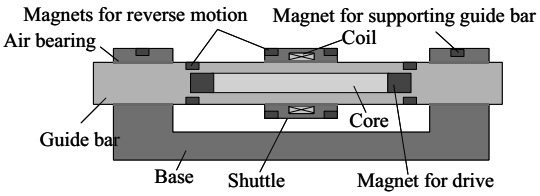


Fig. 1 Cross section of Shuttle Unit

A New Rapid and Precise Image-Rotation Detection Approach

Takamune SATO, Tomomichi KUSAJIMA, Minoru ITO

This paper describes a new approach for detecting image rotation angles with high accuracy. Frequency amplitude distributions of input and reference images are transformed to polar coordinates, and then the position shift between the polar spectra is detected. In the shift detection, weights depending on frequency and amplitude at each frequency are used to precisely calculate the shift. The average and standard deviation of absolute errors for the rotation mode where synthetic reference images are synthetically rotated are 0.007 and 0.0048 degrees, respectively. Those for the rotation/shift modes where real images are rotated synthetically or with a mechanical stage are within 0.004 and 0.003 degrees, respectively.

Study of Nano-Stereolithography Using Evanescent Light (2nd report) -Photofabrication of Fine Lattice Structures Using Standing Evanescent Light-

Yusuke KAJIHARA, Yuichi INAZUKI, Satoru TAKAHASHI, Kiyoshi TAKAMASU

Great demand has arisen for micro-fabrication methods which can be used to precisely fabricate micrometer-order devices. In particular, methods of fabricating MEMS and microscopic optical devices as typified by a photonic crystal are in huge demand. In this study, we propose a novel stereolithography method using evanescent light instead of propagating light to realize a 100-nanometer resolution. We intend to establish nano-stereolithography with higher accuracy and flexibility. In the second report, we fabricated in-plane lattice structures, which are in high demand as diffraction gratings, diffractive optics, photonic crystals, etc. The proposed stereolithography method using evanescent light has a potential to fabricate micro three-dimensional objects with sub-micrometer resolution.

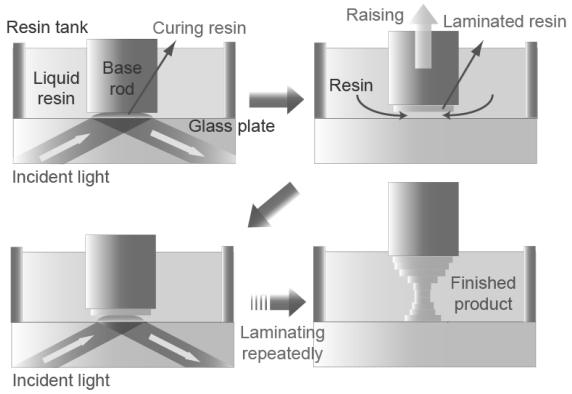


Fig. 2 Schematic diagram of nano-stereolighograpy using evanescent light

2. JSPE NUMATA MEMORIAL PAPER AWARD

Study on the Basic Axis Formation of Ultra Precise Gear Measuring Instrument

Hiroomi OGASAWARA, Noritsugu MAEDA, Teru HAYASHI

This paper presents an Ultra Precise Gear Measuring Instrument/UPGMI, which can measure individual deviations of a gear with sub-micrometer resolution. Highly stabilized measurements of ultra-precise and very fine/minute gears are indispensable for miniaturizing machinery and machine components. To meet these purposes, UPGMI employs a new basic concept of the main spindle of rotational axis, carrying test gear, with vertical travel/motion. We achieved measurement accuracy of submicron order even in a preliminary assembled UPGMI.

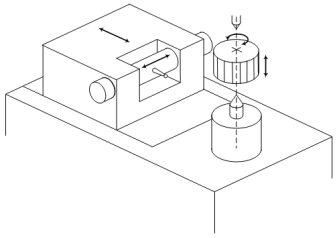
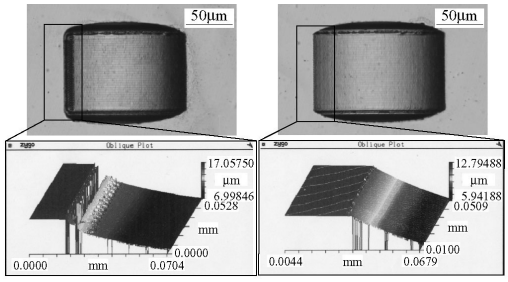


Fig. 3 Outline view of UPGMI

General Tool Setting Error Compensation Method for 5-axis Control Ultraprecision Machining

Makoto SONO, Tohru ISHIDA, Koji TERAMOTO, Toshiyuki ENOMOTO, Yoshimi TAKEUCHI

The study describes development of a new method to compensate the initial position error of a diamond cutting tool in ultraprecision micromachining by use of a 5-axis control ultraprecision machining center. Demand is increasing for fabricating complicated microparts accurately and efficiently by means of a multi-axis control ultraprecision machining center. However, the formation accuracy of machined microparts is deteriorated by accumulation of various kinds of errors due to the increasing number of motion axes and the difficulty of setting small diamond tools. To solve these problems, the study proposes a new method to precisely measure tool radius and to correctly set the tool, and develops an initial tool setting error compensation system. Experimental results confirm the effectiveness of the method proposed in the study.



(a) Original data (b) Compensated data

Fig. 4 Machined cylindrical surfaces with and without compensation of tool setting error in 3-axis control milling

Self-Assembly of Fine Particles using Patterned Wettability -Proposed Assembly Method and Consideration of Conditions for Assembly-

Nobuyuki MORONUKI, Jun-ichi KOGISO, Arata KANEKO

This paper proposes a technique for assembling fine particles that combines the continuous-convective method and patterned wettability. A substrate patterned with hydrophilic or hydrophobic regions is drawn-up at a specific angle from a suspension that contains particles. At the boundary of air/suspension, the particles arrange themselves selectively on the hydrophilic region as water evaporates. We discuss the method of wettability patterning. We also discuss design guidelines focused on the condition to fill up the particles only in hydrophilic regions. Results show that the width and spacing of hydrophilic region should be designed to maintain sufficient supply of particles.

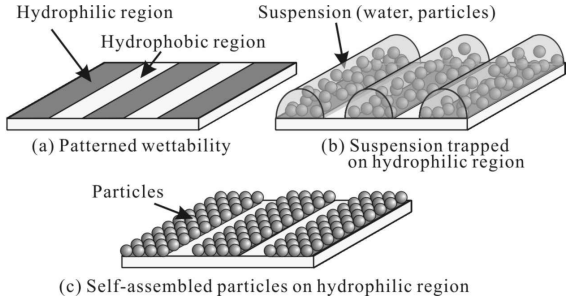


Fig. 5 Concept of self-assembly of particles along patterned wettability

Development of a New Sphere Diameter Measuring Machine

Seiichi HAGIWARA, Yukio MAWAKE, Hisayoshi SAKAI, Takahiro MOROSAWA, Hideki YAMAMOTO, Tetsuya KAMINAGA

A new laser interferometric measuring machine for sphere diameter has been developed. The measuring machine employs a 633 nm commercial stabilized He-Ne laser and a variable length vacuum cell made of metal bellows. So the machine enables the effect of refractive index of air to be excluded. Moreover, a control mechanism for measurement contact force is developed and applied to the measuring machine. Measurement reproducibility of 10.4 nm (σ) is confirmed and 74 nm(k=2) of expanded uncertainty is estimated.

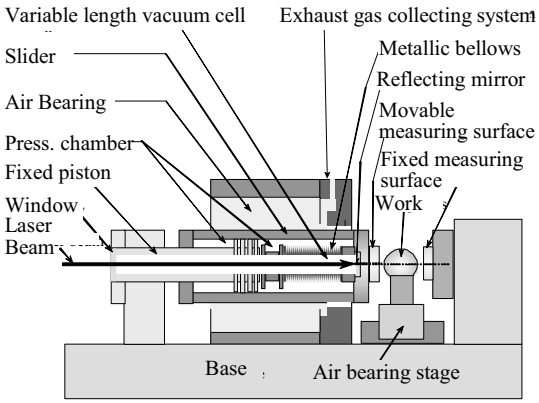


Fig. 6 Structural drawing of the measuring section