The Japan Society for Precision Engineering

Introduction of JSPE Best Paper Awards 2008

Super-Resolution Optical Measurement for Ultra-Precision Machined Surface Defects by Using Structured Light Illumination Shift (1st report) – Theoretical Verification of Resolution Property –

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Demands for ultra-precision machined surface such as semiconductor wafer are rapidly growing. However, shrinking design rules of the semiconductor reduce process yield in manufacturing line. One of the biggest factors of the reduced yield is a nano-defect on the large area surface, so we must develop a defect measurement system with higher resolving power, throughput, non-destructiveness and robustness. Therefore an optical method with higher resolving power beyond the Rayleigh limit is required. In order to develop an optical inspection system with high resolving power, we have proposed the application of the structured light illumination (SLI) microscopy for the defect measurement of the ultra-precision machined surface. It is expected that the resolving power of the system exceed the Rayleigh limit by the SLI, and the robustness is enhanced by a image reconstruction algorithm using multiple images with shifts of the SLI. In the first report, to verify the resolution property of the method, we carried out theoretical examination and the computer simulation. As a result, the proposed method makes it possible to observe a structure with robustness and higher resolution beyond the Rayleigh limit and it is suggested that this method is available to measure defects on the ultra-precision machined surface.

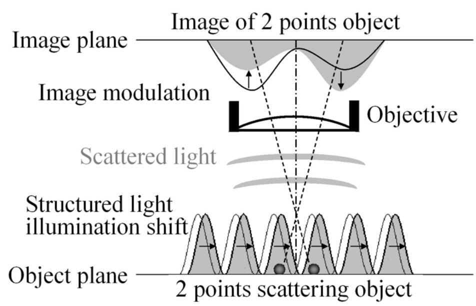

Fig. 1 Schematic diagram of structured light illumination shift and scattered light image modulation

Study on the Cogging Torque Reduction Method of the Motors Using a Rotary Lamination Process

Hiroyuki AKITA, Yuji NAKAHARA, Kimiyasu FURUSAWA, Takashi YOSHIOKA, Yasuhiro TAKAYA

In recent years, the technology which heightens the output per unit volume by equipping a stator with a high-density coil using divided cores is used widely in order to improve the motor output or the motor efficiency. Since the divided cores really tend to generate work errors compared with the non-divided core, magnetic energy changes by few work errors, and there is a problem that the cogging torque known as torque ripple becomes large. Therefore, in the motor which has divided cores, it is useful industrially to obtain the manufacturing method which reduces cogging torque effectively by simple process.

In this research, by using the concentrated magnetomotive force model, the technique of writing the cogging torque resulting from the error of the inside diameter form of a stator as a vector was introduced, and the validity was verified. The rotary lamination method was proposed as a method of reducing cogging torque by making each other offsetting combining two or more torque vectors, and the effect was verified by experiment. In the experiment, the rotary lamination is realized by the manufacturing method with the divided cores which are pierced in the circular shape by a metallic mold. There will be room to study offsetting the torque vector of other factors by control the torque vector arbitrarily using the rotary lamination method of the divided cores.

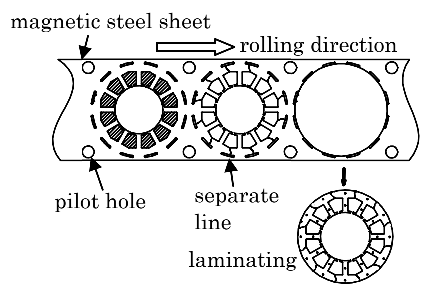

Fig. 2 Stamping process of divided cores in circular shape

Study for Development of Nano-Machining and Measurement System of Machining Center Type

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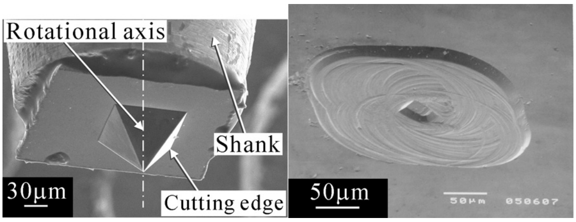

Fig. 3 Single-blade nanomilling tool (left) and nanomilling example (right)

A small precision nanomachining and measurement system was developed with a targeted machining resolution on the order of scales ranging from submicrons to several nanometers. The system was comprised of two machining functions, scratch machining and milling, and one measurement function. The scratch machining function was based on a frictional force microscope mechanism with a closed-loop numerical control (NC) to control the depth of the cut. A stiff cantilever was used for the scratch-machining function to permit nanomachining of hard and brittle materials such as silicon. The milling function used an original miniature tool that had a very small diamond mounted on it that permitted micromachining. The measurement function incorporated into this system used the same mechanism as the scratch-machining function, and provided a degree of precision almost equal to that of atomic force microscopy. After constructing this system, we performed various machining tests with it to confirm that the integrated NC closed-loop control function performed correctly.

Introduction of JSPE Takagi Awards 2008

Optical Fiber Cylindrical-Lensed End Machining with Fiber Bending (1st report) – Theoretical and experimental analyses of wedge processing –

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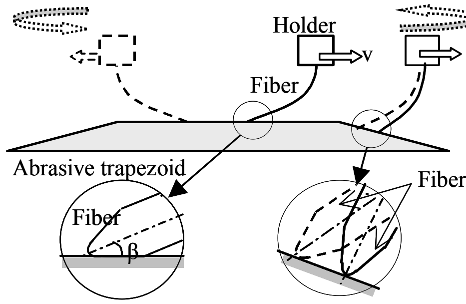
A cylindrical-lensed optical fiber is used for single-mode fiber coupling for 980-nm pump lasers. This aper proposes a new machining method for the cylindrical-lensed end of an optical fiber. The method uses the bending force of the optical fiber which has homogeneous elasticity characteristics. The rational achining condition is clarified from an elasticity analysis.



(a)Tapering tip at level (b) Rounding tip at slope

Fig. 4 Mechanism of cylindrical-lensed end machining with fiber bending

Thermal Stress Analysis on Laser Cross Scribe of Glass

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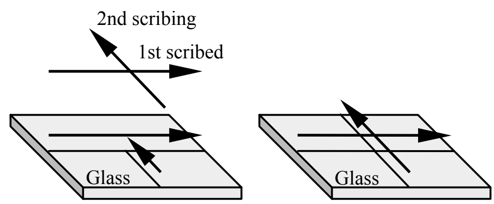
In CO_2 laser scribe processing of glass, an initial crack on the start edge of the glass is indispensable. When carrying out laser cross scribe, there is no initial crack on the edge of the first scribed line. However, the second scribe progresses across the first scribed line. In this research, in order to clarify the phenomena of laser cross scribe, the laser irradiation experiments were carried out at various velocities of the second scribing. Using the same conditions as the experiments, three-dimensional thermal stress analyses were conducted by a finite element method. As a result, two kinds of forms were found in the progresses of the second scribe. One is a form that the first scribed crack surfaces are bonded by strong compression at high temperature in the heating area during the second scribing. The other is a form that the tensile stress in the cooling area which makes the second scribe progress is transmitted by the frictional force generated in the first scribed crack surface. Consequently the second scribe progresses across the first scribed line although there is no initial crack on the edge of the first scribed line.



(a) Stop of the 2nd scribing at the 1st scribed line (b) Progress of the 2nd scribing across the 1st scribed line

Fig. 5 Schematic of laser cross scribe