The Japan Society for Precision Engineering

Introduction of JSPE Best Paper Awards 2020

This award is presented to authors whose papers have been recognized to have the highest originality and high engineering and industrial importance, with the purpose of encouraging academic research and promoting academic development related to precision engineering.

● ***Influence of Microstructure Change on Stress Generation and Relaxation in Coating under High Temperature***

Tadafumi HASHIMOTO and Shuho KOSEKI

J. JSPE, Vol. 86, No. 9, pp. 681-686

To prevent the coating damages of the cutting tools such as abrasion and chipping during machining, the influence of microstructure change on stress generation and relaxation in the coatings during machining should be clarified. However, it was generally difficult to obtain the relationship between stress and microstructure change during machining, because the typical evaluation procedures are known to destruct the cutting tools in order to conduct the microstructure observations. Therefore, the combination of non-destructive evaluation techniques by using X-ray diffraction is proposed. Those are phase identification, crystal orientation analysis, phase fraction measurement, dislocation density measurement and residual stress measurement in the target area from RT to high temperatures. In the case of a cutting tools made of a cemented carbide (K10 of JIS) with TiN coating, the following conclusions were made: the micro strain which has liner relation to dislocation density squared was decreased in TiN coating due to heating over a coating temperature of 500 °C, and that was about half value compared with the original at a temperature of 750 °C. The stress change in TiN coating under high temperatures was composed of three kinds of factors which are the difference of thermal expansion on TiN coating and cemented carbide, the volumetric shrinkage of TiN coating by recovery of the micro strain and the tensile creep strain in cemented carbide. In order to preserve the compressive stresses in TiN coating under high temperatures, the coating process must be carried out at higher process temperatures and in low bias voltages. In addition, cemented carbides should be selected in that of the coarse WC and Co grain size, the low Co compositions and the large amount of precipitates, on account of keeping the low creep rate.

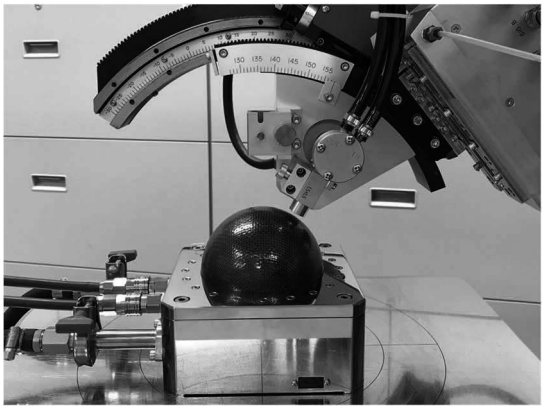

Fig. 1. In-situ measurement system using lab X-ray

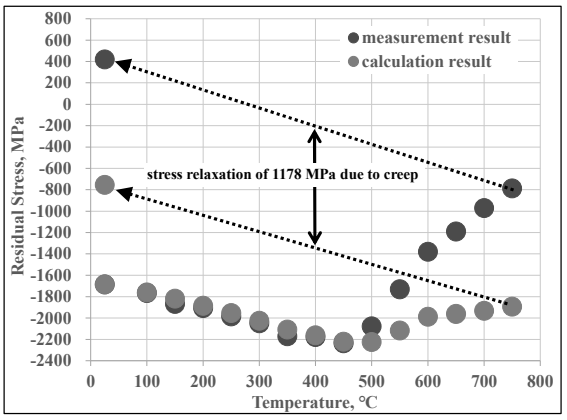

Fig. 2. Stress generation and relaxation mechanism in TiN coating under high temperature

● ***Development of Piezo-Driven Actuator for Segmented Fast Steering Mirror***

Rina NISHIDA, Jianpeng ZHONG and Tadahiko SHINSHI

J. JSPE, Vol. 86, No. 11, pp. 911-916

Laser scanning systems for laser micro drilling and optical inter-satellite communication have required fast steering mirrors (FSMs) with a large diameter. However, increasing the mirror diameter makes the fast positioning more difficult because the elastic mode of the mirror occurs at a lower frequency. To solve the problem, a segmented FSM, in which several small mirror actuators having higher natural frequencies work together to produce the same reflective surface as a large mirror generates, is

proposed. The final target of this research is to achieve a bandwidth of 10 kHz and more with a reflective surface of 50 mm in diameter. For the verification of the feasibility, a multi-axis, high response and small mirror actuator having a single hexagonal mirror with a distance between opposite sides of 18 mm was designed and tested. Each small mirror made of SiC is driven by a combination of tip-tilt and piston drivers using piezoelectric actuators. The fabricated small mirror actuator realized the first natural frequency over 10 kHz. The prototype was tested by a feedback controller with integrators and notch filters. The designed controller achieved the target bandwidths of 10 kHz in all the driving directions.

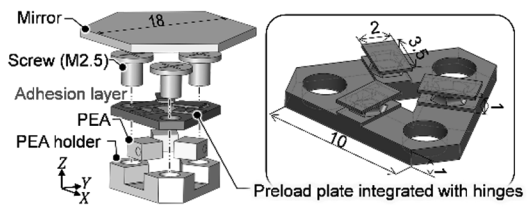

Fig. 3. Configuration and design of the tip-tilt driver

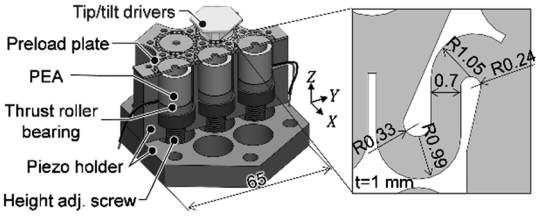

Fig. 4. Configuration and design of the piston driver

● ***Method for generating CNC programs based on block-processing time to improve speed and accuracy of machining curved shapes***

Toshiaki OTSUKI, Hiroyuki SASAHARA and Ryuta SATO

Precision Engineering, Vol. 55, pp. 33-41

Programs for machining curved shapes with CNC (computerized numerical control) machine tools are commonly generated of approximated linear segments based on a set chord error, the so-called 'tolerance' on CAM (computer aided manufacturing) software operation. It is considered that smaller amount of chord error leads to higher machining accuracy. It is also empirically known that the chord error influences the machining time or the movement speed of the machine tool. However, there is no theoretical procedure to set the appropriate chord error for the CNC programs, to reduce the machining error but not decrease the feed speed as much as possible from the commanded one. In this research, we propose a method for calculating a suitable chord error from the curvature radius, commanded feed rate, and CNC block-processing time to generate programs considering the chord error. The results of experiments confirmed higher speed and accuracy of movements with CNC machine tools using programs generated by this method.

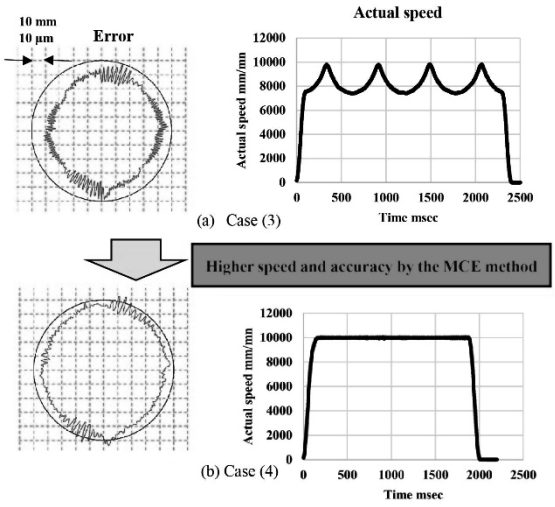

Fig. 5. Comparison between the proposed method (MCE method, (b) Case (4)) and the conventional method ((a) Case (3))

Introduction of FA Foundation Award

This award is presented to authors of academic papers demonstrating superior creativity and high industrial value, who are researchers and engineers from universities, public research institutes, and industries. The award aims to encourage and advance their research and development on "factory automation (FA)," "industrial robots," and "technologies related to these fields" and promote talent development.

[Paper Awards 2020]

● **A machining test to identify rotary axis geometric errors on a five-axis machine tool with a swiveling rotary table for turning operations**

Soichi IBARAKI, Ibuki YOSHIDA and Tetsushi ASANO

Precision Engineering, Vol. 55, pp. 22-32

● **Precision Slicing of Single Crystal Silicon Using Laser Slicing Technology**

Yohei YAMADA, Junichi IKENO and Hideki SUZUKI

J. JSPE, Vol. 85, No. 5, pp. 419-425