The Japan Society for Precision Engineering

Introduction of JSPE Young Researcher Awards 2020

This award is presented to young and energetic researchers who have published highly innovative papers in recognition of their efforts and dedication and to motivate them to conduct further research.

● ***Hiroki IWAI (Okayama University)***

Influence of nozzle jet flushing on corner shape accuracy in wire EDM

J. JSPE, Vol. 86, No. 6, pp. 480-485

In wire electrical discharge machining (EDM), wire brakeage often occurs and the shape accuracy tends to deteriorate when cutting corner shapes. However, the influence of jet flushing conditions on the debris exclusion and wire deflection in the corner shape cutting has not yet been investigated so far, while the influences of discharge conditions and spark distribution wire were studied. In this study, the flow fields and debris movements in the machined kerf during the corner shape cutting in 1st-cut wire EDM were simulated by CFD analysis. Also, the wire deflection was discussed by a structural analysis of wire with stress distribution due to hydrodynamics force obtained by the CFD analysis. The results showed that the flow and pressure fields around the wire by jet flushing and the debris movements in the kerf significantly changed just after changing the cutting direction at the corner. Additionally, the corner shape error with wire deflection was experimentally measured and compared to the analytical result of wire deflection with hydrodynamics force. It was found that the influence of hydrodynamics force on wire deflection was as large as discharge explosive force under general 1st- cut conditions, which suggests that the influence of jet flushing on the corner shape accuracy is large under jet flushing conditions with relatively high flow rate.

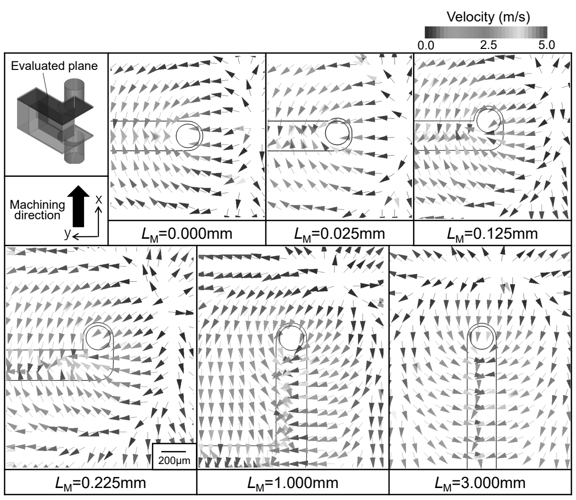

Fig. 1. Flow fields above upper workpiece surface

● ***Kazuki TACHIBANA (The University of Tokyo)***

Smart optical measurement probe for autonomously detecting nano-defects on bare semiconductor wafer surface: Verification of proposed concept

Precision Engineering, Vol. 61, pp. 93-102

We propose a new method of inspecting a surface for fine defects that combines the optical inspection method with observation of the physical behavior of a liquid. A liquid thin film on a substrate behaves as a near-field physical probe that autonomously captures nano-particulate defects. Optical observation of the interfacial behavior of the liquid thin film is used to detect minute defects. This method combines the characteristics of optical detection (i.e., detection from a remote field and simultaneous detectability on a plane) and the high sensitivity of a physical near-field probe. We examined the basic principles of the proposed method through numerical calculation and applied it in experiments to detect fine particulate defects on a silicon substrate for semiconductor manufacturing to demonstrate the validity of the basic concept of the proposed method.

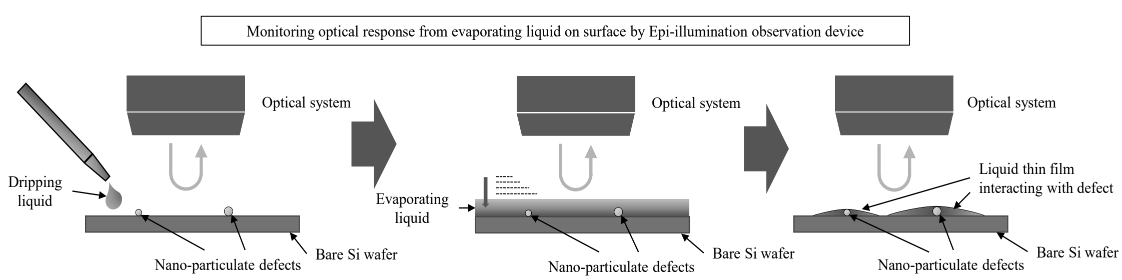

Fig. 2. Principle of the proposed inspection method

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● ***Guodong LI (Tokyo University of Agriculture and Technology)***

Realization of micro EDM drilling with high machining speed and accuracy by using mist deionized water jet

Precision Engineering, Vol. 61, pp. 136-146

In electrical discharge machining, both the gas and liquid dielectric have unique advantages and inevitable disadvantages. The mist medium with a special property between gas with liquid is expected to have a better performance in EDM. In this paper, the performance of mist deionized water jet has been studied based on the disadvantages of deionized water in deep micro hole drilling: electrolysis action, electrophoresis action and gap-contamination by debris. Based on the analyzation on the advantages of mist jet, three projects of experiments have been done to verify its performance on the suppressing of electrolysis action and improving the debris exhaust. The results show that the micro EDM drilling with high machining speed and accuracy can be realized with mist jet. This method is particularly effective in deep micro hole drilling, since deeper holes can be obtained at faster machining speed with mist jet due to its significant improvement in debris exhaust.

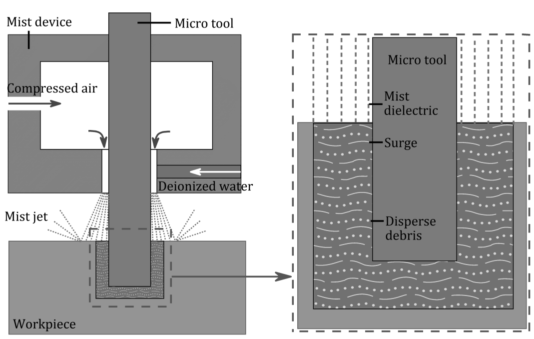

Fig. 3. Principle of mist jet

● ***Shunsuke FUJIMAKI (Okuma Corporation)***

Proposal of "Curved-Profile Wiper Turning" for efficient, stable, and smooth finishing

Precision Engineering, Vol. 61, pp. 152-159

This paper presents an efficient, stable, and smooth turning method for curved-profile workpieces. Conventional wiper tools can achieve high efficiency, high chatter stability, and smooth surfaces at the same time only for linear-profile workpieces. A novel method is proposed, which extends the wiper tool concept to the curved-profile turning. In this method, a suitable wiper-edge radius is chosen for better smoothness, and the tool posture is controlled for higher regenerative chatter stability. Curved-profile turning experiments are conducted, and high efficiency, high chatter stability, and smooth surfaces are achieved at the same time by the proposed method.

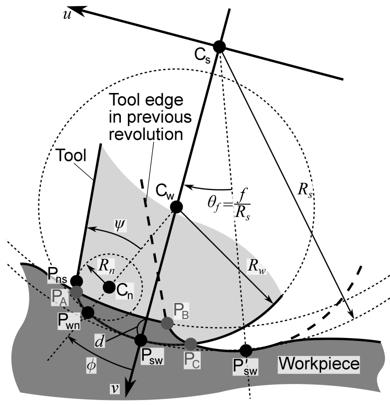

Fig. 4. Geometry for curved-profile wiper turning

● ***Yuki JOROBATA (Kyoto University)***

Cutter mark cross method for improvement of contact stiffness by controlling distribution of real contact area

Precision Engineering, Vol. 63, pp. 197-205

Contact surfaces do not make contact perfectly because such surfaces have a lot of asperities. The real contact area is much smaller than the nominal contact area, and the real contact areas has a non-uniform distribution because of the waviness in the contact surface. The contact stiffness is influenced not only by the deformation of the asperities, but also by the distribution of the real contact areas. In general, a contact surface with a uniform distribution of the real contact areas has greater contact stiffness. However, this requires a grinding finish and costs more than the cutting finish. In this study, a method for uniformly distributing the real contact areas easily, is proposed to improve the contact stiffness of a contact surface finished by cutting. The method is called the cutter mark cross (CMC) method. The allowable waviness in the CMC method is shown. In addition, the effect of the CMC method is investigated by experimentation. The results show that the real contact areas can be distributed uniformly using the CMC method. The horizontal and vertical contact stiffness can also be improved.

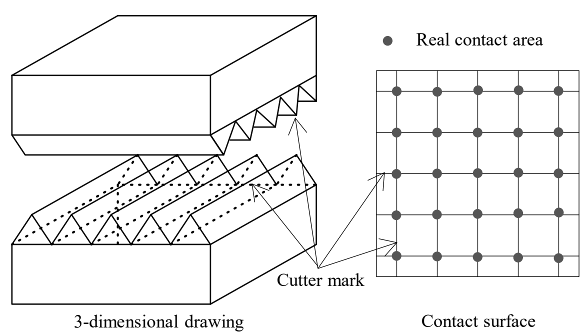

Fig. 5. Schematic of the cutter mark cross (CMC) method