The Japan Society for Precision Engineering

Introduction of JSPE PRIZES 2015

1. Toshiro DOI (Kyushu University)

Professor Toshiro DOI has long been engaged in the research and development of ultra-precision processing technology and its applications. His innovative research has led the world and greatly contributed to the development of the field, especially in the research and practical applications of the ultra-precision planarization CMP (Chemical Mechanical Polishing) processing technology, which has become essential to the recent semiconductor device manufacturing. He won a variety of awards, including the Technology Award and Best Paper Award from JSPE.

He served as the first chairperson of the "Planarization and CMP Technical Committee" established in JSPE. Highly motivated to educate researchers and engineers, he actively managed the committee, and has edited and published many technical books. Through these activities he has lead the committee to one of the largest organizations in JSPE with 121 participating companies at a maximum. For his significant contributions to the development of JSPE, he has won the JSPE Best Organizer Award constantly and Takagi Award twice. In 2004, the committee proposed the creation of an annual international conference on CMP (PacRim on CMP: the current ICPT [International Conference on Planarization/CMP Technology]) and founded it. In 2014, "Development Of Intensified CMP & Application Award (DOI Award)" was established in ICPT for the purpose of memorizing his achievements and fostering the young.

Now, he is engaged in research and development of next-generation materials for green devices and their innovative ultra-precision processing methods as professor emeritus and specially-appointed professor at Kyushu University, as well as serving as the chairperson of the 136th Committee on Future-Oriented Machining of Japan Society for the Promotion of Science (JSPS).

Fig.1 Prof. Toshiro DOI

Professor Toshiro DOI has considerably contributed not only to research and development in the field of ultra-precision processing technology and its practical applications, but also to promotion of academic, educational and industrial activities. He has made a significant achievement in the field and raised the fame of JSPE.

2. Yoshikazu NAKAMURA (MITAKA KOHKI Co., Ltd.)

Mr. Yoshikazu (Giichi) NAKAMURA joined the Tokyo Astronomical Observatory, University of Tokyo (the present National Astronomical Observatory of Japan), in 1947. Giichi learned about structures and designing techniques of precision equipment while repairing various devices as a technical officer. In 1966, he established Mitaka Kohki Co., Ltd. (MITAKA). MITAKA developed many astronomical telescopes and observational equipment for artificial satellites. She contributed to research on X-ray astronomy and unveiling the production mechanism of aurora.

In 1988, MITAKA advanced into the medical device industry, especially microsurgery in neurosurgery, as she strongly desired to make helpful devices rather than useful ones. In 1992, she developed and produced laser probe 3D measuring instruments, which won the JSME Excellent Product Award in 2007 and JSPE Technology Award in 2014. The International Organization for Standardization (ISO) named the measurement principle devised by MITAKA as point autofocus profiling and standardized it in 2014.

Giichi made a significant contribution to the development and production of not only astronomical instruments but also medical and industrial instruments that find wide application in Japan and abroad. He has a unique manufacturing craftsman philosophy. He lectured on his philosophy to many manufacturing companies in Japan. He received the Order of the Rising Sun, Gold and Silver Rays in 2006.

Introduction of JSPE Technology Awards 2015

Depth of field extension technology for two-dimensional code reader

Chie NAGASHIMA, Toshihiko TSUKADA (TOYOTA CENTRAL R&D LABS., INC.), Kunihiko ITO, Yoshimi KITAZUMI (DENSO WAVE Co., Ltd.), Shinichi KOMATSU (WASEDA UNIV.)

The two-dimensional code represented by the QR code is used widely in the logistics and retail industry and also to maintain privacy. To increase the application of two-dimensional code, the ability to read two-dimensional codes in the range of a few meters by a single reader is strongly desired. In order to meet the above demand, the technique of wavefront coding was applied to extend the reading depth of a two-dimensional code reader. In the wavefront coding method, images of the same blurring ahead and behind the focus position are captured by a lens with a special shape, called a phase plate. To restore the image in focus before and after the focal position, inverse transform processing of the blur is performed by image processing on the captured image. As a result, the depth of the focus is enlarged.

The design of the phase plate should address the effects of spatial quantization noise due to the size of the element of the image sensor and a luminance quantization of the element. Therefore, the extension width of the reading depth that depends on the shape of the phase plate was preliminary estimated by a computer simulation. Subsequently, we constructed a phase plate and an optical system having it in the image sensor. In this system, the phase plate, which had a curved surface in three dimensions, was arranged in a pupil plane of the imaging lens. We measured the blurring of the image by imaging the actual pinhole, and developed an algorithm for restoring the image without blur by inverse transformation in the frequency domain. The developed optical system was included in a two-dimensional cord reader and the readable distance range of a cord was evaluated by comparison with the conventional model. While the conventional system could read the QR code of 1 mm cell in the range of 250~450 mm, the developed system could read the code in the range of 200~1200 mm, and the performance was 5 times better than that of the conventional system. Currently, research for further performance improvement is being continued before finalizing the product for marketing.

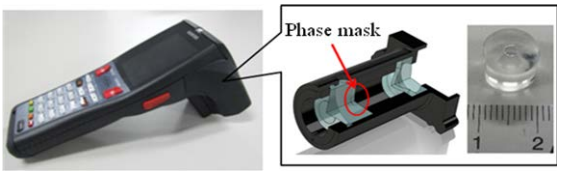

Fig.2 Prototype of two-dimensional code reader

Introduction of FA Foundation Award

[Paper Awards 2015]

1. Study on Polishing Mechanism of Single Crystal Substrate by UV-Excitation

Mutsumi TOUGE, Takugi NAGANO, Tomohiko TAGAWA, Takeshi SAKAMOTO, Hiroyuki YOKOI, Chihiro IWAMOTO and Junji WATANABE

J.JSPE, Vol.80, No.1, pp.112-116

Diamond has superior characteristics such as the highest thermal conductivity and dielectric breakdown field, and is expected to be a good candidate material for the next generation semiconductor device. On the other hand, the etching and the mechanical processing are much difficult because of chemical and physical stabilities of diamond. As the device materials must be polished without the crystallographic distortion beneath a polished substrate, the simplified planarization techniques accompanied with high surface quality is intensely required. The ultraviolet rays excited polishing of single crystal diamond substrates has been studied in our laboratory. The UV-polishing characteristics, such as higher polishing rate and superior final surface roughness, have been revealed in these many years. This work will interpret the UV-polishing mechanism to achieve a well-polished diamond substrate satisfied for the requirement of the semiconductor device materials. The effects of the ultraviolet irradiation and processing atmosphere on the polishing rate and surface integrities were carefully examined. The polishing mechanism was discussed using experimental results of the luminous phenomenon, CO gas concentration and TEM observation of abrasion powder. The polishing model based on these discussions was proposed, and high-grade diamond wafer was finally obtained by the UV-polishing under the polishing conditions decided by the proposed polishing model.

2. Analytical Study on Response Characteristics of Optical Instruments for Measuring Surface Texture

Akihiro FUJII, Shinichi HAYASHI, Shintaro FUJII, Tomotake TERASAWA and Kazuhisa YANAGI

J.JSPE, Vol.80, No.9, pp.851-855

This paper deals with design concept of physical measurement standards for optical surface measuring instruments. Using the finite-difference time-domain (FDTD) method, a new simulation tool was developed to analyze optical scattering phenomena on a fundamental laser scanning microscope and to investigate the measured results for inclined plane and sinusoidal, rectangular and triangular cross-section surfaces. Some reasons for outlier inclusion in the measurement results were also made clear. Guidelines for designing the standard surfaces were proposed from a viewpoint of their local geometry within a focused beam spot of the instrument under test.