【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Engineering Ⅰ)

Title of Project : A new high speed nano-profiler using the normal vector tracing method for next generation ultraprecision mirrors.

Katsuyoshi Endo
(Osaka University, Graduate School of Engineering, Professor)

Research Area : Mechanical engineering

Keyword : Production engineering, Profiler, Measurements, Ultraprecision machining

【Purpose and Background of the Research】

In order to develop third generation synchrotron radiation and X-ray free electron laser (XFEL) sources, the ultraprecision asymmetric mirrors which realize nano-focusing and high coherence are indispensable. In industry, the high accurate asymmetric mirrors are required for extreme ultraviolet (wave length is 13.5nm) lithography which is a promising fabrication technology for semiconductor devices. And the ultraprecision mirrors which are small curvature radius less than 10mm are needed for many digital video instruments.

The purpose of this study is to develop a new high speed nano-profiler by tracing the normal vector of mirror surface, for XFEL, EUVL and digital video instruments. The specifications are as follows. The maximum area of measurement is 500mm × 300mm. The accuracy of measurement is more than 1nm. The measuring time is less than 5min/sample.

【Research Methods】

Figure 1 shows the principle of profile measurement. This measuring method is based on the straightness of laser light and accuracy of rotational goniometer. The normal vectors of each point on the mirror surface are determined by making the incident light beam on the surface and the reflected beam at that point coincident using 2 set 2 pair goniometers. The profile is calculated by the measuring points and normal vectors on the surface. An original algorithm is developed using least squares method based on Fourier series.

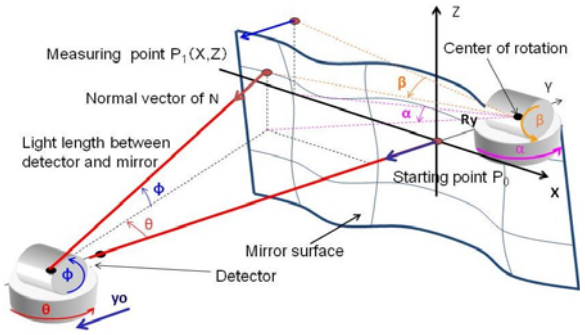

Figure1 The principle of profile measurement.

【Expected Research Achievements and Scientific Significance】

If this nano-profiler is developed, only one surface fabrication system is achieved with our ultraprecision machining technique. The ultraprecision asymmetric mirror manufactured by using the surface fabrication system is important in the field of fundamental science and industry as follows.

① Nano-beam hard X-ray computerized tomography microscope for the observation of inside cell.
② Full coherent focusing mirror for XFEL.
③ Ultra-precision mirror for next generation EUVL.
④ On machine measurement to fabricate the metal mold for the highly accurate asymmetric mirror.

【Publications Relevant to the Project】

・High Precision profile measurement of a small radius lens by Surface Gradient Integrated Profiler: Y.Higashi, T.Ueno, S.Tachibanada, J.Uchikoshi, T.Kume, K.Enami, K.Endo, SPIE symposium on "Advances in X-Ray/EUV Optics and Components IVPaper No. 7448-3, 2-6 August 2009, San Diego, CA, USA

・Development of surface gradient integrated profiler, - precise coordinate determination of normal vector measured points by self-calibration method and new data analysis from normal vector to surface profile, Y. Higashi, T. Ueno, K. Endo, J. Uchikoshi, T. Kume, K. Enami, Proceedings of the SPIE, Vol. 7077-12, August, 2008, San Diego, CA, USA

【Term of Project】 FY2010-2013

【Budget Allocation】 156,400 Thousand Yen

【 Homepage Address and Other Contact Information】

http://www.upst.eng.osaka-u.ac.jp/21coe/atom/measure.html
endo@upst.eng.osaka-u.ac.jp