Nano-Positioning Control of Condenser Mirror for Soft X-ray Microscopy System Using 5-axis Manipulator

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This paper presents a method of a nano-positioning control for the high precision focusing of a doubled ellipsoidal condenser reflective mirror using 5-axis manipulator. We have developed the compact vertical type of soft X-ray microscopy system with 50nm resolution for biomedical application. This microscopy system is composed of a laser plasma x-ray source, doubled ellipsoidal condenser reflective optics, diffractive zone plate optics and MCP coupled with CCD to record an x-ray image. The X-ray source was focused on a sample by a doubled ellipsoidal condenser reflective mirror. X-ray source focusing will increase the photon density in the object plane and is very important to approach high resolution imaging. Required degree of freedom (DOF) of optics aligner in X-ray microscope is dependent on the kind of optics, but generally 5-DOF is needed. We used 5-axis manipulator that consists of three linear motions (X, Y and Z) and two tilting motions (R_x, R_y). A linear translation stage is adopted a kind of DC motor with a linear resolution 50nm and travel range of 5mm. The mechanism was controlled with PID controller augmented with closed feedback loop for precision control. A two axis tilt stage is employed a design resolution of 0.23μrad and tilt range of ±7deg. We have designed 5-axis manipulator for the precision position control of condenser mirror optics and have developed to control algorithm by inverse kinematics. The performance of the proposed 5-DOF manipulator is evaluated by using a laser interferometer system with two plane mirror reflectors. The experimental results are depicted in this paper.

References

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