

Development of Algorithm for Automatic Alignment of Soft X-ray Microscope Condenser Mirror using Response Surface Method

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Nowadays, many kinds of microscope for living cell are researched and developed. Especially, A X-ray microscope is popular among them. At the first time, we introduce a Vertical Soft X-ray Microscope (VSXM) with a Double Ellipse Condenser Mirror (DECM) and a Zone Plate (ZP) as its focusing unit. Concretely, the VSXM is composed of a target chamber, a mirror chamber, and an image detection part. In the VSXM, the DECM is used to illuminate a specimen. In order to get clear image of a specimen, it must be illuminated uniformly and in maximum intensity (broadly). However, at the integration of the VSXM, the DECM is decentered, tilted, and defocused. Due to the errors, the DECM doesn't illuminate a specimen uniformly and in maximum intensity (broadly). In addition to the requirement, because the quality of images acquired lastly in CCD sensitively reacts to the errors and the DECM cannot be manually aligned by hand in a few micron, an automatic alignment algorithm and system are required. In result, this paper proposes algorithm for automatic alignment of DECM. The automatic alignment algorithm is based on Response Surface Method (RSM) that is a kind of experimental design methods. RSM is a statistical analysis method of response surfaces that variations of responses make, when several explanatory (independent) variables have complicate relationship between them and influences on a response (dependent) variable. In addition, because the VSXM is incongruent to be used in general laboratory environment, this paper suggests a simulator to verify the proposed alignment algorithm. The simulator includes an alternative light source (635nm Fiber Optic Diode Laser), an alternative DECM, an alternative ZP and an alternative detector (CCD). In result, decreasing the errors of decenter, tilt, and defocus, we could align the DECM to illuminate uniformly and broadly a specimen. And for an ideal state (cost function value = 1) that no errors exit, we could reduce CM errors within 5%, that is, Cost function value is 0.95.