Digital Phase Difference Amplification in X-ray Interferometer

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Early in 1965 U. Bonse and M. Hart suggested X-ray interferometry methods. In recent years, A. Momose and colleagues have been extending the techniques to the applications in biological and medical, and introduced the techniques into computed tomography as well. By taking a series of interferometry patterns at different rotational orientations of a sample, a three-dimensional picture of the refractive index of the sample can be reconstructed. With this method, they have studied the cancerous tissues of human breast, liver, and kidney and rabbit cancer lesions as well as a rat cerebellum using radiation at the Photon Factory in Tsukuba. Their results illustrate the potential advantages of phase contrast imaging and the sensitivity to minute density variations—on the order of $10^{-9}g/cm^3$.

In this paper, a method concerning digital phase difference amplification for X-ray interferometers is suggested, aims at improving the sensitivity of X-ray interferometers for the measurements of biological samples. Phase information is amplified digitally by phase difference amplification by means of Fourier transform from two different interference patterns, wherein one includes the information of the object, and the other only the background of the system.

As we know the interference pattern contains the image from the object and, overlapping the carrier wave fringes in the X-ray interferometer, so the pure phase information can be extracted from interference patterns by eliminating the carrier wave component. In this method, phase difference can be amplified up to 100~1000 times, it means the sensitivity to minute density variations—can be on the order of $10^{-12}g/cm^3$.

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