Coherent X-ray Diffraction Imaging with Single-pulse Table-top Soft X-ray Laser

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ABSTRACT

We demonstrate coherent x-ray diffraction imaging using table-top x-ray laser at a wavelength of 13.9 nm driven by 10-Hz ti:Sapphire laser system at the Advanced Photonics Research Institute in Korea. Since the flux of x-ray photons reaches as high as 10^9 photons/pulse in a 20 × 20 μ ı^2 field of view, we measured a ingle-pulse diffraction pattern of a micrometer-scale object with high dynamic range of diffraction intensities and successfully reconstructed to the image using phase retrieval algorithm with an oversampling ratio of 1:6. the imaging resolution is ~150 nm, while that is much improved by stacking the many diffraction patterns. This demonstration can be extended to the biological sample with the diffraction limited resolution.

Coherent x-ray diffraction microscopy has been a method advanced recently to imaging non-periodic objects with no optical elements.[1] Different from the typical microscopy techniques, phases in coherent diffraction imaging can be retrieved by computational algorithm with the oversampling ratio larger than 2. In most experiments based on synchrotron sources, multiple-pulses diffraction patterns are measured to increase the dynamic range that reduces consequently significantly the artifacts in phase retrieval and improves the imaging resolution as well. Most recently, lensless diffractive imaging using table-top coherent high-harmonic soft x-rays has been demonstrated.[2] However, they illuminate the objects within 120 min to take the high dynamic range of diffraction patterns because a number of x-ray photons are limited. Then, the parallax by long-term instability is definitely unavoidable.

In this study, we have exploring a challenging work to imaging the objects with coherent x-ray laser driven by 10-Hz Ti:Sapphire laser system. Figure 1(a) shows the optical microscopy image of sample used in this study. Actually, the sample is Au #2000 mesh on the pinhole of 20 μm in diameter. The bar is 5 μm and the hole is 7.5 μm square. Figure 1(b) shows the measured single-pulse diffraction pattern. We can reconstruct the image using phase retrieval algorithm[3] (data not shown).[4]

The authors would like to acknowledge the support of the Ministry of Commerce, Industry, and Energy of the Republic of Korea through "Core Technology Development Program". This work was also supported by KOSEF through by the "National Research Lab. Program" funded by the MOST (No. M10400000045-04J0000-04510).

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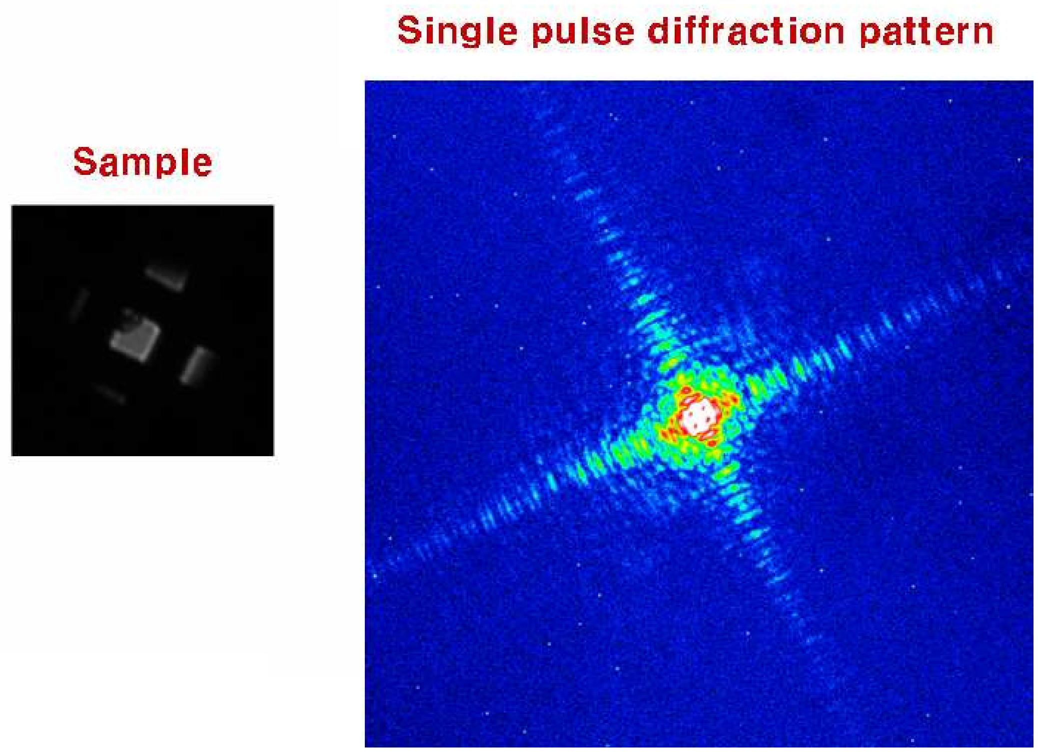

Figure 1. (a) Optical microscopy image of sample. (b) Measured diffraction pattern.