Full-field imaging and focusing with advanced mirror-based optics

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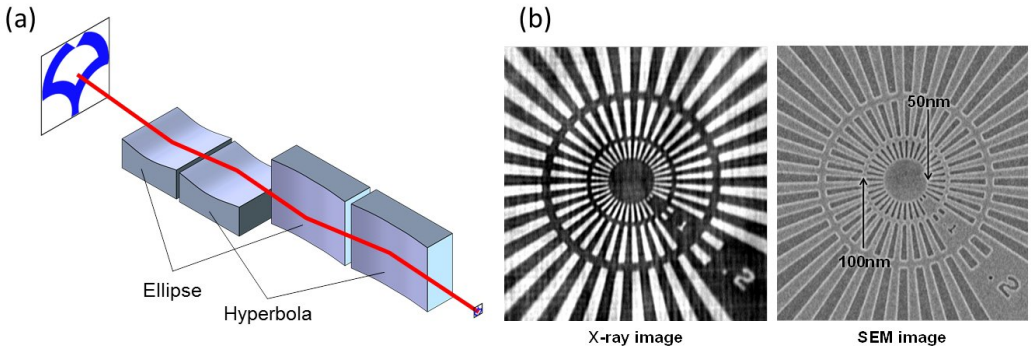
Ultraprecise X-ray mirrors are very useful for full-field X-ray imaging and focusing in synchrotron radiation facilities and X-ray free-electron laser facilities. Kirkpatrick-Baez mirrors is often used as focusing optics since they offer achromaticity, high reflectivity, and large acceptance. However, they suffer from comatic aberration, resulting in unstable focusing due to narrow incident-angle error tolerances, and allow for full-field imaging only with a very narrow FOV. Recently, we successfully developed advanced mirror-based optics comprising two elliptical and hyperbolic mirrors, or advanced Kirkpatrick-Baez mirror optics (Fig. 1(a)). This configuration overcomes comatic aberration by approximately meeting Abbe's sine condition. Figure 1(b) shows its typical performance when used in full-field imaging optics, demonstrating the resolution of a 50-nm feature in the test chart[1]. In this presentation, we describe three topics: (1) achromatic full-field imaging, (2) multilayer imaging mirrors toward high-resolution and high-energy imaging, and (3) a new, compact system with convex and concave mirrors[2].



(a) Advanced Kirkpatrick-Baez mirror optics. (b) Bright-field X-ray image of a fine star chart.

References

[1] S. Matsuyama *et al.*, 50-nm-resolution full-field X-ray microscope without chromatic aberration using total-reflection imaging mirrors, Sci. Rep. **7**, 46358 (2017).

[2] J. Yamada, S. Matsuyama *et al.*, Simulation of concave–convex imaging mirror system for development of a compact and achromatic full-field x-ray microscope, Appl. Opt. **56**, 967 (2017).