A Multidisciplinary Optical Microscope of Ultra-High Definition Imaging

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Born in 1947. Given D. Sc., (Physics) from the Department of Physics, Graduate School of Science, Gakushuin University in 1974. Started working as a research fellow at the University of York in the United Kingdom from 1975. Became a research associate at the Research Institute for Scientific Measurements, Tohoku University, in 1981 and promoted to a professor in 1998. He continued the professorship at the current Institute since 2001 after the reorganization of the Institute.

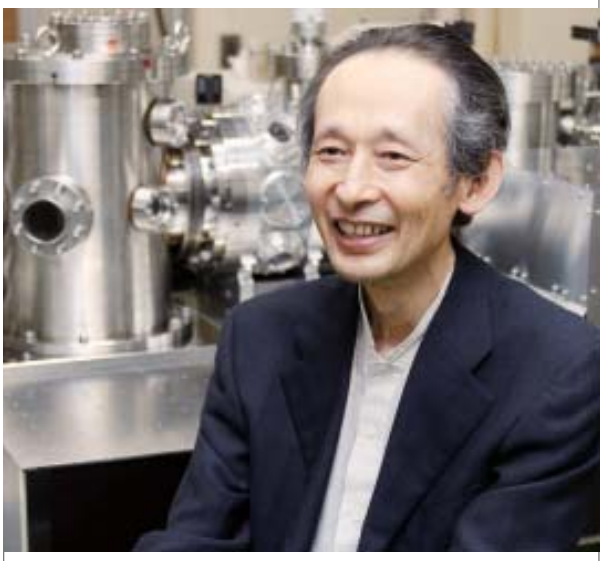
Prof. Masaki Yamamoto, et al., Institute of Multidisciplinary Research for Advanced Materials, Tohoku University, developed a "multidisciplinary optical microscope" characterized by its wide optical field of view with ultra-high resolution of soft X-rays. This ultra-high definition imaging microscope is formally called a "Transmission X-ray Multilayer Mirror Microscope: TXM^3."

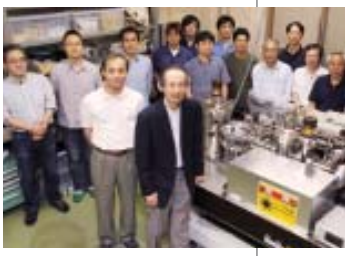
An observation of a piece of material as small as 1/10000 millimeter uses an electron microscope. However, an object needs to be dried because water interferes. In particular, a living object cannot be observed as it lives.

On the other hand, a TXM^3 captures and fixes the action of living cells at a particular moment, and is powerful in multidisciplinary research including hybrids such as plastic and polymer. More specifically, this microscope fits for soft material sciences.

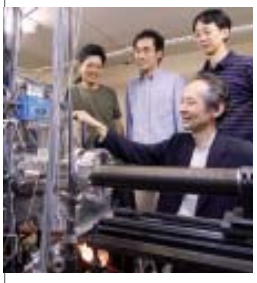
Prof. Yamamoto's group had been working on soft X-ray optics. Soft X-rays, safely absorbed in the air, do not penetrate a lens nor are reflected by a metal mirror, and thus, no standard optics is available. Therefore, his group made a multilayer reflective mirror where molybdenum and silicon is coated in many alternate layers. They also developed a device to control the thicknesses of layers at a precision of 1/100 of the size of an atom so that an image is exactly in focus. As a result, they have achieved one shot imaging of a 0.2mm wide field of view at a resolution of 100 nanometer(1/10000 mm) for the first time, which is to be improved further to 1/3. Soft X-rays, like light, are insensitive to electric or magnetic field disturbance, which is essential advantage in the field of nanotechnology and beyond.

This optical microscope capable of ultra-high definition imaging with the largest size of the image data, recorded by one shot, will innovate the uses of a microscope.

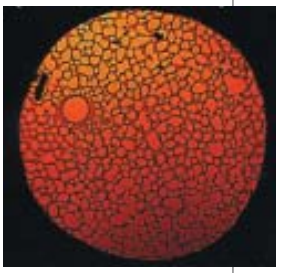




Staff in the research laboratories of Prof. Masaki Yamamoto and Prof. Mihiro Yanagihara, and technical room. The microscope main body and its precision components were made in affiliated factories.



Soft X-ray multi-layer coater for an imaging mirror. Slight unevenness in the molybdenum and silicon coatings on the curved surface of a mirror could easily distort the image. Adjusting the mirror surface by 0.1 nanometer.



One shot imaging of a polymer micro grid by TXM^3. Its diameter is 0.1 mm. A field of view of 0.2 mm can be imaged in one picture at a resolution of 100 nanometer. A polymer made of light elements is transparent to electrons, and is used as a support mesh for a sample of an electron microscope.

Prof. Yamamoto got a new idea of 3D shape measurement from his favorite prism, and aims for practical use.
"I catch principles, have a wide range of interest, and spread the imagination. It's a pleasure for me to come to new ideas, that drive me to continue," said Prof. Yamamoto.

http://www.tagen.tohoku.ac.jp/labo/m_yamamoto/indexTok.htm