Three-dimensional X-ray Microholographic Microscope

Technology Reference
CM05

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Key Word(s)

- microscopy
- holography
- X-ray

Stage of Development

- Prototypes of the microscope need to be built and tested for the various applications.

Description

This discovery will enable high resolution, three-dimensional visualizations of hydrated tissue at a molecular level. The technology has two separate components: a) an X-ray laser, and b) an X-ray holographic camera designed specifically for biological specimens. The imaging of extremely small objects requires extremely short wavelengths, such as those corresponding to X-rays. Because of the enormous power density required, it is technically very demanding to produce these short wavelength by conventional physical processes, making the imaging of extremely small objects prohibitively expensive and difficult, if not impossible. However, the availability of an X-ray laser can overcome these difficulties and lead, for example, to the three-dimensional imaging of living hydrated material with molecular resolution. This discovery may put biological/molecular imaging and its applications within reach. By subjecting clusters of xenon atoms to intense ultraviolet (UV) radiation powerful X-ray pulses are produced from a highly unusual state of excited matter. The xenon atoms eject inner-shell electrons upon receiving the UV radiation, leaving a "hollow atom". When the remaining outer electrons rush to fill the vacancy, they produce X-rays of wavelengths as short as 100 angstroms. There are plans to try the technique with heavier atoms, such as uranium, to produce even stronger pulses down to wavelengths as small as 30 angstroms. On the other hand, a prototype holographic camera is ready and functioning. An important and fundamental property of this camera is its ability to operate over a very wide range of wavelengths spanning from the visible region to the x-ray range. The concept, which involves the Fourier holographic configuration, is able to accommodate this broad variation in wavelength through appropriate but simple adjustments in the parameters of exposure and the electronic system used for detection.

Field of Application

The broad extent of acceptable wavelengths for the camera implies a correspondingly wide range of biological and medical applications. For example, analysis shows that

	this form of direct holographic microscopy is generally applicable to the study of the structure, properties, and action of genetic material. Specifically, it can be applied to a sequential progression of studies spanning from investigations at visible wavelengths of banded polytene chromosomal structure to the determination of the sequence of the human genome through use in the x-ray region. Furthermore, these considerations suggest particular important clinical applications. Namely, the three-dimensional visualization of cells derived from biopsy, in their natural context, appears likely to enable a considerably refined diagnosis of malignant and pre-cancerous states. **Advantages** Unlike electron microscopy, which generally requires stained and desiccated specimens, this new technology combines a main feature of the light microscope, the ability to observe hydrated living matter, with the principal capability of the electron microscope, the power to resolve very small spacial elements.
References	