Plasmonic Dark Field Microscopy

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BACKGROUND

Dark field (DF) microscopy is widely used to view objects that have low contrast in bright-field microscopy, e.g., live and unstained biological samples. In conventional DF microscopy, the central part of the illumination light that ordinarily passes through and around the sample is blocked by a light stop, allowing only oblique rays to strike the sample. While conventional DF microscopy can achieve high contrast imaging, its resolution may also be improved by using a high numerical aperture (NA) configuration of the condenser/objective pair. However, the NA of the objective cannot be larger than that of the condenser to avoid having the oblique illuminating rays enter the objective. Also high NA condensers are very sensitive to alignment and must be accurately positioned and aligned to the very sharp cone of illumination, making them difficult to use. In addition, the illumination light in such a high NA arrangement must be very bright, which is wasteful of energy. Thus conventional DF microscopy is instrumentally bulky, complex, and costly.

TECHNOLOGY DESCRIPTION

UC San Diego researchers have developed a new optical imaging technique referred to as “plasmonic dark field” (PDF) microscopy. Instead of the lenses, light stops, and mirrors of conventional dark field microscopy, PDF microscopy uses a “plasmonic condenser” (PC) to guide the sample illumination angle. In one embodiment, the PC is essentially comprised of a metallic structure that converts light into surface plasmons. Since surface plasmons exist only at the metal surface, they appear completely dark in the far field. Only when an object is brought in the near field of the metal surface will light couple into the far field to form a perfect dark field image. The invention also includes active plasmonic couplers that use media, e.g., luminescent materials that provide mechanisms for exciting surface plasmons in a metal layer. The PC devices can be fabricated using well-established processes. Proof-of-concept for the invention has been achieved by numerical simulations and experiments. In particular, a chip-scale integrated multilayered fluorescent active PC has been used to demonstrate the new imaging technique.

ADVANTAGES

PDF microscopy promises to deliver unprecedented performance in terms of spatial resolution, optical contrast, and device miniaturization and versatility at low cost.

RELATED MATERIALS

- *Plasmonic Dark Field Microscopy*, Appl. Phys. Lett. 96, 113107 (2010); see http://circuit.ucsd.edu/~zhaowei/Journals/APL_Hu.pdf

PATENT STATUS

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OTHER INFORMATION

KEYWORDS

dark field microscopy, microscopy, surface plasmons, optical condenser, low contrast, optical imaging

CATEGORIZED AS

- **Medical**
  - Research Tools
- **Nanotechnology**
  - NanoBio
  - Tools and Devices

RELATED CASES

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