NATURE NANOTECHNOLOGY | RESEARCH HIGHLIGHTS

Our choice from the recent literature

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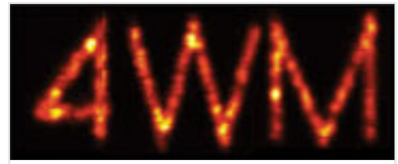
Microscopy: A better shot in the dark

Nano Lett. doi:10.1021/nl1033304 (2010)



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Dark-field microscopy relies on keeping radiation that has not been scattered by the sample of interest away from the optics that are used to form the final image. This approach offers improved sensitivity and signal-to-noise ratio, but it also reduces resolution. Now Lukas Novotny and colleagues at the University of Rochester and two research centres in Spain — the ICFO and the ICREA, both in Barcelona — have shown how this problem can be overcome through the use of nonlinear optics.

The new approach relies on a process called four-wave mixing in which two lasers of different frequencies, ω_1 and ω_2, interact with each other to produce an electromagnetic field with a frequency $2\omega_1 - \omega_2$. When the angles of incidence for the two laser beams have certain values, the four-wave mixing field is evanescent — that is, it decays with distance rather than propagating through space. However, when it is scattered by the sample, it is converted into a propagating field that can be collected by an objective lens and used to form a dark-field image of the sample.

Novotny and colleagues used their approach to image patterns made by depositing titanium dioxide on a gold substrate to spell '4WM', and by scratching a silicon surface with an atomic force microscope. They also found that the contrast of the images depended on the relative alignment of the features in the sample and the plane defined by the two laser beams.

Oxygen doping: Easier detection

Science doi:10.1126/science.1196382 (2010)

Modifying the sidewalls of single-walled carbon nanotubes can affect the optical and electronic properties of the tubes. Covalent reactions have been used to join different chemical groups to the sidewalls of nanotubes but these reactions randomly erode the ordered π-electron structure and suppress the near-infrared fluorescence signature peaks of the tubes. Bruce Weisman and colleagues at Rice University have now shown that introducing a low concentration of oxygen atoms to single-walled carbon nanotubes can systematically change their optical properties for better detection.

To prepare the oxygen-doped nanotubes, Weisman and colleagues exposed an aqueous suspension of pristine, semiconducting single-walled carbon nanotubes to low doses of ozone followed by light. Fluorescence spectroscopy showed that treated samples had distinct near-infrared fluorescence at longer wavelengths than pristine tubes, and Resonance Raman spectroscopy confirmed the presence of covalently bonded oxygen in the treated samples. The red-shifted emission, which is absent in pristine nanotubes, meant that the doped nanotubes were more readily detected in