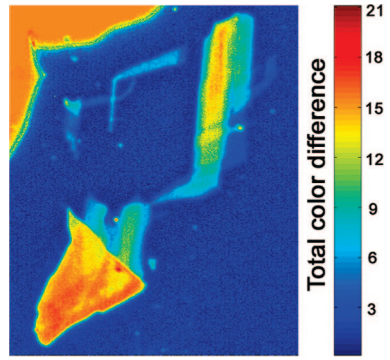
Color by Number for Graphene Layers

Graphene has a variety of unique electronic, optical, and mechanical properties that continue to attract interest from researchers pursuing fundamental physics studies and potential applications alike. Because the properties of graphene can change strikingly with its thickness, rapid and accurate identification of the layer number can be crucial for selective preparation of graphene. Previously, investigators have found that optical methods offer the potential to characterize large-area graphene samples quickly and nondestructively. Some research teams have used reflection and contrast spectroscopy with white light, which causes areas of graphene with differing thickness to exhibit distinct color bands that can be seen with the naked eye. However, this method is prone to inaccuracy and can be difficult to quantify,

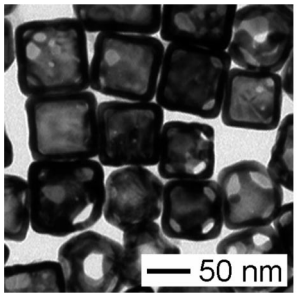


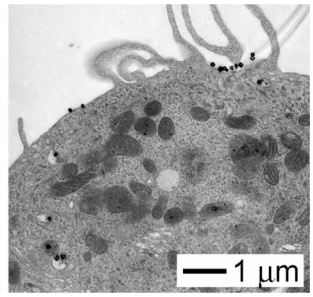
especially when there is only a marginal difference in color between a particular substrate and graphene of various layers.

Attempting to improve the identification and characterization of graphene, Gao *et al.* (p 1625) propose a total color difference (TCD) method based on a combination of the reflection spectrum calculation and International Commission on Illumination color space to research the effect of light source and substrate on graphene optical imaging. With this method, the researchers found that using a 72-nm-thick Al_2O_3 film works better as a substrate than more commonly used silicon-based films. Additionally, these investigators discovered that the TCD between monolayer graphene and substrate, as well as between different layers of graphene, can be further improved by narrowing the wavelength range of the light source. These findings offer a new way to characterize graphene nondestructively for basic and applied use.

Nano-Caging Cancer Cells

Researchers have recently demonstrated the promise that Au nanoparticles hold for cancer therapy. These nanostructures have high biocompatibility and well-established surface chemistry, which allows investigators to target particular cells selectively by attaching various biofunctional moieties. The strong optical absorption of some Au nanostructures makes them ideal candidates for phototherapy, in which light is converted to heat *in vivo* to kill cells via hyperthermia. Though research groups have developed a variety of Au nanostructures for this purpose, few quantitative studies have determined the optimal parameters for cancer therapy, such as the number of immobilized Au nanostructures per cell, the waiting time after irradiation, and the duration of laser exposure.

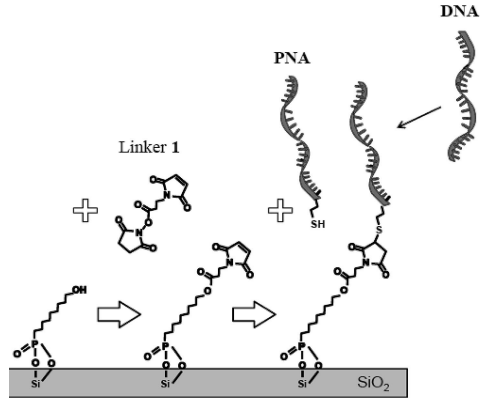




Toward better determining these parameters, Au *et al.* (p 1645) performed a quantitative study using Au nanocages (hollow structures with porous walls) conjugated with monoclonal antibodies targeted to SK-BR-3 cells, a well-characterized cell line that overexpresses the epidermal growth factor receptor 2, also known as HER2. The researchers treated SK-BR-3 cells with Au nanocages having an edge length of ~65 nm. Their results showed that ~400 nanostructures attached to each cell, with some particles internalized by the cells. Using propidium iodide staining, an indicator of cell death, the researchers were able to optimize the intensity and duration of laser treatment for targeting cell death to a particular area while minimizing collateral damage to nearby healthy cells. The authors note that these results mark an early quantitative step toward making phototherapy an effective and noninvasive option for cancer therapy.

News of DNA Hybridization Comes Over the Wires

Seeking new ways to sense DNA hybridization while avoiding fluorescent tagging of the target DNA molecules, researchers have recently begun investigating the possibility of using silicon-based field-effect devices. These devices rely on detecting changes in the electrical surface potential that occur when charged DNA is adsorbed. For these devices to detect DNA hybridization effectively, they require a suitable organic interface with a high density of receptor binding sites and a short linker distance between the surface and the probe DNA or its analogue, peptidic nucleic acid (PNA). Previously, research groups have tried various approaches to this end, including tethering DNA nonspecifically to a poly-L-lysine layer on the substrate surface or covalently bonding DNA to an end-functionalized siloxane layer grafted onto the surface. However, these interfaces have several shortcomings, including limited hydrolytic stability and the intrinsic risk of multilayer formation.



Seeking a new platform for detecting DNA hybridization, Cattani-Scholz *et al.* (p 1653) functionalized SiO_2-terminated Si surfaces with PNA oligonucleotides using alkyl-phosphonate monolayers. The PNA oligonucleotides act as receptors for DNA and hold significant advantages over using probe DNA, including a greater increase in net charge before and after hybridization. The researchers characterized their newly developed system using several analytical methods, including contact angle measurements, X-ray photoelectron spectroscopy and reflectivity, atomic force microscopy, and fluorescence spectroscopy. They demonstrated that this system can be used for Si nanowire sensor devices that effectively detected DNA/PNA hybridization. As one possible application, the researchers plan to incorporate these devices into microfluidic systems.

Published online August 26, 2008.
10.1021/nn800490f CCC: $40.75