Researchers demonstrate an electrochromic nanoplasmonic optical switch

September 1 2011

In a recent article in *Nano Letters*, CNST researchers describe a new high-contrast, low operating-voltage, electrochemical optical switch that uses a volume of active dye orders-of-magnitude smaller than that of conventional electrochromic devices.

Electrochromism refers to a reversible change in the optical absorption of a material under an applied voltage. Inorganic and organic electrochromic materials are used in displays, smart windows, and car rearview mirrors. A change in light absorption in such a material is caused by a change in the oxidation state, and requires that both ions and electrons diffuse through the material. Decreasing the material's thickness reduces the diffusion time, making the electrochromic switch faster, but unfortunately also reduces the contrast.

The NIST and University of Maryland researchers have grown crystals of the electrochromic dye Prussian Blue inside a gold nanoslit waveguide where light propagates as a surface plasmon polariton (SPP). SPPs are collective charge oscillations coupled to an external electromagnetic field that propagate along an interface between a metal and a dielectric.

The dye nanocrystals, deposited on the sidewalls of the slit by cyclic voltammetry, can be electrochemically switched to provide a transmission change ≈ 96 % (in the red) using control voltages less than 1 V. The high switching contrast is enabled by the strong spatial overlap between the SPPs and the nanocrystals confined within the slit. The contrast is also enhanced by the unexpectedly high absorption coefficient of Prussian Blue nanocrystals grown on a gold surface compared with bulk material.

The switch operates efficiently even with a relatively low fill fraction of active material in the slit (≈ 25 %), leading to a large contact area with the electrolyte. Because the light propagates in a direction perpendicular to the direction of the charge transport between the electrolyte and the ultrathin dye layer inside the nanoslit, the new switch design offers significant promise for creating electrochromic devices with record switching speeds.

More information: An integrated electrochromic nanoplasmonic optical switch, A. Agrawal, C. Susut, G. Stafford, U. Bertocci, B. McMorran, H. J. Lezec, and A. A. Talin, *Nano Letters* 11, 2774-2778 (2011).

Provided by National Institute of Standards and Technology