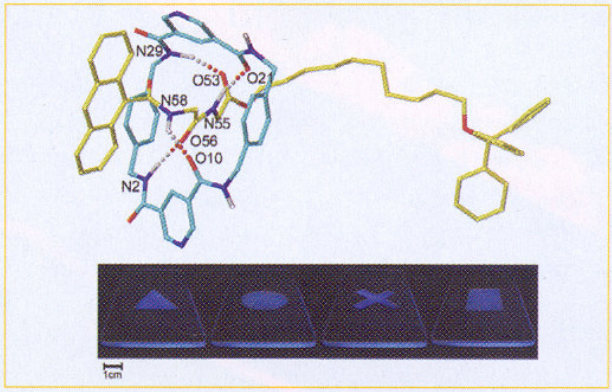
Switches based on submolecular movement

POLYMERS

David A. Leigh and coworkers at the UK universities of Edinburgh, St. Andrews, and Warwick, Amsterdam in the Netherlands, and Università degli Studi di Bologna in Italy have developed a polymer film molecular switch, or logic gate, based on controlling submolecular positioning without making or breaking chemical bonds (Leigh *et al.*, *Angew. Chem. Int. Ed.* (2005), doi 10.1002/anie.200500101).

The researchers used a rotaxane molecule consisting of a macrocyclic ring threaded on a chain that has two end groups to prevent it from slipping free of the ring. Rotaxanes provide a mechanism for nanoscale molecular switches in which the relative positions of the interlocked components can be changed in response to an externally applied input. The change in position can vary physical properties such as conductivity, circular dichroism, and fluorescence, so providing a molecular switch.

Leigh and colleagues describe a system in which changes in the local environment induce movement of the macrocyclic ring along the thread. This movement switches the fluorescence of the rotaxane 'on' or 'off'. The system works both in solution and in polymer films, where controlled submolecular motion upon light irradiation generates patterns visible to the naked eye.



(Top) Structure of the rotaxane molecule. (Bottom) Fluorescent switching in rotaxane polymer films. (© 2005 Wiley-VCH.)

The translational isomerism of the macrocyclic ring and thread components of the rotaxane is controlled to either permit or prevent fluorescence quenching by intercomponent electron transfer. No chemical bonds are formed or broken in this process, so the optical response is a result of changes in the relative positions of the macrocycle and the thread. Thus, a visible response results from a purely mechanical submolecular event.

This behavior has potential applications in sensing and security applications. Electrochemistry, temperature change, pH change, or covalent-bond formation could also be used to induce this process as well as light.

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