Porphyrin Based Molecular Wires

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Harry Anderson's research group at Oxford University is exploring the synthesis and behaviour of porphyrin-based molecular wires for a wide range of applications. Porphyrins are large flat aromatic molecules which occur widely in biology — they are the dyes that make blood red and grass green. We make molecular wires by linking these molecules together in such a way that electrons can easily move between the individual porphyrin units.

Part of this project is concerned with measuring how quickly electrons move through porphyrin-based wires. This work involves synthesising wires with electron-acceptors at one end and electron donors at the other end; we then measure the rate of photoinduced electron transfer through the wire, as a function of the length of the wire. *The Mass Spectrometry Service at Swansea has provided crucial help in characterising these synthetic structures.*

One of the remarkable properties of porphyrin based molecular wires is their ability to absorb two photons of light simultaneously. They have extremely high two-photon cross sections. This has many applications. For example it can be used to protect delicate sensors from intense light, in a process known as optical power limiting.

We are also investigating medical applications of two-photon absorption in photodynamic therapy. Here the porphyrin dimer is used as a drug. When it is excited inside a living cell, its excited state is able to convert ordinary molecular oxygen into excited-state singlet oxygen, which then kills the cell. The amount of two-photon absorption depends on the square of the light intensity, so the effect can be pin-pointed to regions of very high light intensity. We hope that these porphyrin based molecular wires might eventually be used to treat eye diseases such as age-related macular degeneration.

FAB and MALDI mass spectrometry are vital techniques for characterising these metalloporphyrins and porphyrin oligomers; mass spec often provides the first reliable indication of a successful synthesis, and it can be the only way of establishing, for example, that a particular compound is a dimer rather than a trimer.

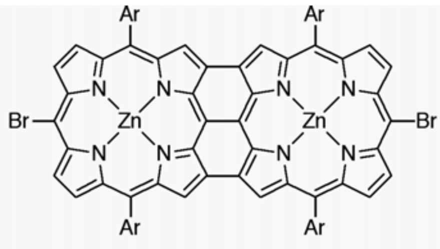
Publications:

"Synthesis, crystal structure and nonlinear optical behavior of -unsubstituted *meso-meso E*-vinylene-linked porphyrin dimers", M. J. Frampton, H. Akdas, A. R. Cowley, J. E. Rogers, J. E. Slagle, P. A. Fleitz, M. Drobizhev, A. Rebane and H. L. Anderson, *Org. Lett.* **2005**, *7*, 5365–5368.

"Synthesis and crystal structure of a push-pull quinoidal porphyrin: a nanoporous framework assembled from cyclic trimer aggregates", M. J. Smith, W. Clegg, K. A. Nguyen, J. E. Rogers, R. Pachter, P. A. Fleitz and H. L. Anderson, *Chem. Commun.* **2005**, 2433–2435.

"Extremely strong near-IR two-photon absorption in conjugated porphyrin dimers: quantitative description with three essential states model", M. Drobizhev, Y. Stepanenko, Y. Dzenis, A. Karotki, A. Rebane, P. N. Taylor and H. L. Anderson, *J. Phys. Chem. B.* **2005**, *109*, 7223–7236.

Examples of optoelectronic materials under investigation:



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