

Other common types of chromophore do not provide this directionality which is inherent in ruthenium(II), osmium(II) and rhenium(I) polypyridine complexes. Of these complexes, those based on ruthenium(II) or osmium(II) look to be the more promising because of their amenable absorption and emission spectral profiles and their facile oxidation-reduction processes.

We should also consider, at this stage, the feasibility of constructing molecular-scale wires that promote unidirectional and long-range electron tunnelling. Several such systems have been described (9) and many more seem certain to emerge in the near future. Perhaps the most effective bridges are those based on polyenes (2), where charge transfer has been observed to occur over distances in excess of 30 Å. These spacer moieties are probably too unstable for practical purposes, hence our utilisation of polyynes, although there have been innovative

attempts to provide both protection and inherent redundancy.

Other types of bridge, such as those formed from polycondensed aromatic residues (4–6) or DNA (16), provide a more stable environment and exhibit interesting properties.

Theoretical models, predicting very small attenuation factors for electron tunnelling through certain materials, are also beginning to appear (17) and major advances are taking place in the synthetic practices used to fabricate supramolecular entities (9). These various factors combine to ensure that appropriate molecular wires will soon be available. The next step will involve anchoring the wires to a macroscopic support and, by using scanning tunnelling electron microscopy and time-resolved reflectance spectroscopy, the means to study such interactions are in place. One might argue, therefore, that the age of molecular electronic devices is drawing ever closer.

References

- 13 V. Grosshenny, A. Harriman, M. Hissler and R. Ziessel, *Platinum Metals Review*, 1996, 40, (1), 26–35
- 14 M. Hissler and R. Ziessel, *J. Chem. Soc., Dalton Trans.*, 1995, 893; A. Harriman, M. Hissler, R. Ziessel, A. De Cian and J. Fisher, *J. Chem. Soc., Dalton Trans.*, 1995, 4067
- 15 G. McDermott, S. M. Prince, A. A. Freer, A. M. Hawthornthwaite-Lawless, M. Z. Papiz, R. J. Cogdell and N. W. Isaacs, *Nature*, 1995, 374, 517
- 16 A. M. Brun and A. Harriman, *J. Am. Chem. Soc.*, 1994, 116, 10383
- 17 A. K. Felts, W. Thomas Pollard and R. A. Friesner, *J. Phys. Chem.*, 1995, 99, 2929

Preparation of Platinum/Polymer Nanocomposites

A simple method of producing metal/polymer composites, in which nanosized metal particles are homogeneously distributed throughout the polymer, would promote the development of a new generation of useful materials and devices. These devices would utilise the specific compositions and size-dependent electrical, chemical and magnetic properties of the composite. Some syntheses for specific applications have been reported, but no general synthesis for such a nanocomposite material has emerged.

Now, however, scientists at the University of Massachusetts, U.S.A., have developed a synthesis for making platinum/polymer composites (J. J. Watkins and T. J. McCarthy, "Polymer/Metal Nanocomposite Synthesis in Supercritical CO₂", *Chem. Mater.*, 1995, 7, (11), 1991–1994). Their method involves the use of a supercritical fluid, in this case carbon dioxide. As a supercritical fluid, carbon dioxide offers great control over composite composition and

structure and has a high permeation rate in polymers. Carbon dioxide is also a versatile process solvent and it is clean and environmentally friendly.

The precursor, dimethyl(cyclooctadiene)platinum(II), was dissolved into the carbon dioxide, and then sequentially impregnated into, and reduced in, thick films of the polymers poly(4-methyl-1-pentene) and poly(tetrafluoroethylene). The reduction to metallic platinum was by hydrogenolysis and thermolysis. This resulted in platinum/polymer composites containing platinum clusters, of sizes from 15 to over 100 nm (depending upon preparation) being dispersed throughout the films. The sizes and distributions of the platinum clusters were measured by SEM and TEM.

In general, adjusting the permeation and reduction rates controls the size and distribution of the platinum clusters, and further work is being done to produce gradient structures.