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Conducting Polymer Interconnects for Platinum Nodes

Since the development of ultra-small electrical circuitry, molecular electronics and artificial neural networks, the search to find ways of providing electrical connections between such nanosize three-dimensional structures has become a priority. The use of conventional mechanical or photolithographic fabrication techniques is inadequate for direct linking of such structures. Connecting these "molecular wires", by using various chemical techniques to direct the linkage such as conducting organic polymer strands, has been the most successful so far, but a general technique for connecting large numbers of "molecular wires", independently of each other, has not yet been found.

Now, however, researchers at the University of California, San Diego, have demonstrated the ability to interconnect many individual platinum nodes in three dimensions by an electrochemical polymerisation technique (C. L. Curtis, J. E. Ritchie and M. J. Sailor, "Fabrication of Conducting Polymer Interconnects", *Science*, 1993, **262**, 2014–2016).

Their technique is based upon the ability of conductive polymers, such as poly(3-methylthiophene), to be electrochemically switched between electronically conducting and non-conducting states. Pairs of platinum wires in an array, immersed in a solvent of monomer/electrolyte, were independently electrically linked by polymer dendrites on passing an alternating current between them. When an actively polymerising strand electrically contacts a non-conductive strand, the non-conductive strand switches into its conductive state in the region close to the connection. Further polymerisation then occurs in the contacted region to reinforce the connection. The process requires no external mechanical manipulation or lithographic patterning. By using a separate insulating step, sets of electrically independent nodes can be prepared. The insulation of the electrically active links was performed by subsequent electropolymerisation of 4-vinylpyridine or 2-methylthiophene or, more consistently, by dip-coating the connections into a tetrahydrofuran solution of polystyrene.

The polymer connections display several properties relevant to neural networks, fuzzy logic or other nanofabricated model systems. In theory, a large number of nodes could be connected by this method, with the strength of each connection being determined by the conductivity between the node and the network. Therefore, it is expected that with further research, this non-mechanical technique could lead to the construction of complex three-dimensional nanosize interconnected arrays.

High Temperature Palladium Superconductor

Since the first high temperature YBaCuO superconductors were found in 1986, there has been much research to establish their basic mechanism and to find modifying elements which would increase the critical temperature. Copper oxides have usually been employed in these superconductors since they have a very high transition temperature, but no new families of intermetallic compounds with high transition temperatures have been discovered since the niobium binaries in 1953.

Now, however, researchers at AT&T Bell Laboratories in New Jersey, the University of Tokyo and the Technical University, Delft, have reported superconductivity at 23 K in a multiple-phase bulk sample of yttrium palladium boride carbide. (R. J. Cava, H. Takagi, B. Batlogg, H. W. Zandbergen, J. J. Krajewski, W. F. Peck, R. B. van Dover, R. J. Felder, T. Siegrist, K. Mizuhashi, J. O. Lee, H. Eisaki, S. A. Carter and S. Uchida, *Nature*, 1994, **367**, (6459), 146–148).

The transition temperature of this palladium quaternary intermetallic is higher than that of any previously reported for a bulk intermetallic compound. The superconductivity was observed for a narrow range of compositions at relatively low carbon contents. The superconducting volume fraction was large, even though the material was not single-phase. In addition, superconductivity was observed in small quantities in yttrium-palladium-boron alloys with no added carbon. It is suggested that yttrium palladium-boride carbide may be a new family of high-transition temperature superconductors.