Metal-conductive polymer hybrid nanostructures: preparation and electrical properties of palladium□polyimidazole nanowires

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Abstract:

A simple, convenient method for the formation of hybrid metal/conductive polymer nanostructures is described. Polyimidazole (PIm) has been templated on □-DNA via oxidative polymerisation of imidazole using FeCl3 to produceconductive PIm/DNA nanowires. The PIm/DNA nanowires were decorated with Pd (Pd/PIm/DNA) by electroless reduction of PdCl42- with NaBH4in the presence of PIm/DNA; the choice of imidazole was motivated by the potential Pd(II) binding site at the pyridinic N atom. The formation of PIm/DNA and the presence of metallic Pd on Pd/PIm/DNA nanowires were verified by FTIR, UV-Vis and XPS spectroscopy techniques. AFM studies show that the nanowires have diameters in the range 5□45 nm with a slightly greater mean diameter (17.1 ± 0.75 nm) for the Pd-decorated nanowires than the PIm/DNA nanowires (14.5 ± 0.89 nm). After incubation for 24h in the polymerisation solution, the PIm/DNA nanowires show a smooth, uniform morphology, which is retained after decoration with Pd. Using a combination of scanned conductance microscopy (SCM), conductive AFM and two-terminal measurements we show that both types of nanowire are conductive and that it is possible to discriminate different possible mechanisms of transport. The conductivity of the Pd/PIm/DNA nanowires, (0.1 - 1.4 S cm-1), is comparable to the PIm/DNA nanowires (0.37 ± 0.029 S cm-1). In addition, the conductance of Pd/PIm/DNA nanowires exhibits Arrhenius behaviour (Ea = 0.43 ± 0.02 eV) as a function of temperature in contrast to simple Pd/DNA nanowires. These results indicate that although the Pd crystallites on Pd/PIm/DNA nanowires decorate the PIm polymer, the major current pathway is through the polymer rather than the Pd.

Keywords:

DNA, conductivity, synthesis, palladium, polymer

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