Polymeric Metal Wires

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The miniaturization of linear agglomerates of metallic nanoparticles embedded in a polymer matrix leads to polymeric structures resembling metal wires with atomic diameter that are stabilized by appropriate ligands. Soluble materials of this kind are rare but have been accomplished, e.g., with derivatives of Magnus' green salt (which itself is insoluble), i.e. compounds of the type $[Pt(NH_2R)_4][PtCl_4]$ (R represents an alkyl group), and poly(dialkylstannane)s, i.e. compounds of the type $(SnR_2)_n$.

Magnus' green salt and its derivatives are composed of the charged coordination units $[Pt(NH_2R)_4]^{2+}$ and $[PtCl_4]^{2-}$, which leads to a self-assembled quasi-one-dimensional structure comprising a linear array of platinum atoms, as a result of the electrostatic attraction of the consecutive, oppositely charged metal complexes. Poly(dialkylstannane)s contain a backbone of covalently bounded metal atoms which directly form a metal wire. Hence, in spite of their completely different chemical composition, both of these structure types can therefore be regarded as molecular metal wires surrounded by a jacket of organic matter.

The Magnus' salt derivatives and the poly(dialkylstannane)s can be processed with common techniques applied for polymers into oriented films or fibers. Depending on their exact nature, these compounds show semiconductivity, dichroism or liquid crystallinity even below room temperature. One of these compounds was applied as active semiconducting layer in field-effect transistors which showed remarkable stability towards air and water.