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Electrically active, doped monocrystalline silicon nanoparticles produced by hot wire thermal catalytic pyrolysis

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ABSTRACT

Doped silicon nanoparticles have successfully been produced by hot wire thermal catalytic pyrolysis at 40 mbar and a filament temperature of 1800 °C, using a mixture of silane and diborane or phosphine. All particles are monocrystalline with shapes ranging from an octahedron to varying degrees of truncation of this basic shape, with an average diameter of 22 nm. To determine the doping activity, the resistivity of the nanopowders was measured at successive compression levels. While boron doped particles have clean surfaces and are electrically active, with compacted powder having a resistivity of the order of 10^3 Ω m, phosphorus doped particles are covered by an oxide layer whose thickness increases from 0.3 nm to 0.6 nm with higher phosphine concentrations. Furthermore, the phosphor atoms are localised at the interface to this surface layer, where they are electrically inactive. These powders have a resistivity in the order of 10^7 Ω m.