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Biosynthesis, optimisation and characterisation of gold nanoparticles using fungal extracts

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The development of techniques for the synthesis of nanoparticles of well-defined size, shape and composition is a challenge and an important area of research in nanotechnology. Many microorganisms have the ability to produce inorganic nanostructures and metal nanoparticles with properties similar to chemically synthesized materials and are a good alternative approach to chemical synthesis. In the present study, extracellular synthesis of gold nanoparticles (AuNPs) in the presence of fungal extracts has been successfully demonstrated to manipulate the size and shape of gold nanoparticles by alteration of key growth parameters (Temperature, pH, incubation period, and sodium citrate concentrations) and reaction conditions (Supernatant: $HAuCl_4$). Production of nanoparticles was confirmed by the colour change from yellow to violet-blue after ~72 h of reaction. The synthesis of the AuNPs was monitored by UV-visible spectroscopy which showed an absorbance peak at ~530 nm which was specific for gold nanoparticles. The particles thereby attained were characterized by Transmission electron microscopy (TEM), dynamic light scattering (DLS), Fourier transform infrared (FTIR) and energy dispersive X-ray (EDX) analysis. TEM images revealed that the nanoparticles were spherical, triangular, rod-shaped, polygonal and irregularly shaped with indefinite morphology in the range of 3-460 nm in size. The most promising results were obtained when the fungus was grown at pH 3, 40°C and the best parameters for the synthesis of gold nanoparticles were pH 3, 32°C, 40 h, 5 mM sodium citrate concentrations and ratio of 1:100. The GNPSs were monodisperse, spherical and found to be 3-53 nm in size. FTIR absorption spectrum showed the presence of bonds due to O-H stretching (around ~3,430 cm-1). This peak indicates the presence of proteins and other organic residues, which might have been produced extracellularly during the growth of the fungus. An elemental composition analysis employing EDX showed the presence of a strong signal from gold atoms. However, there were other EDX peaks for C, O, Cr, Cu and Fe, suggesting that they were mixed precipitates from the fungal extracts and the copper disks. This study represents an important advancement in the use of of fungal enzymes for the biosynthesis of highly stable gold nanoparticles by a greener approach and this proposed mechanistic principal might serve as a set strategy for the synthesis of nanostructures with desired morphology and can be amenable for large scale commercial production and technical applications.

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Influence of deposition parameters on formation of cobalt nanowires

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To understand the mechanism for formation of fcc-cobalt nanowires in electrodeposition, we have systematically studied the effect of deposition potential, pH, deposition temperature and electrolytic cell concentration on the formation of fcc Co nanowires by X-ray diffraction (XRD), transmission electron microscope (TEM) and scanning electron microscope (SEM). The Co nanowires deposited at the potential of -1.6V are pure hcp phase. When increasing the value of potential to -2.0 V, there are hcp Co and fcc Co crystals in the deposited nanowires. The fraction of fcc Co crystals in the nanowires increases with increasing the potential value. At -3.0 V, the nanowires are pure fcc Co. The pH of the solution has little effect on formation of fcc Co nanowires. We have also seen that high concentration and low temperature favors fcc phase whereas low concentration and high temperature favors hcp phase. However, at 35°C the co-occurrence of hcp and fcc phases were also observed. These experimental results can be explained by the classical electrochemical nucleation theory. The formation of fcc Co crystals can be attributed to smaller critical clusters formed at a higher potential value since the smaller critical clusters favor formation of fcc nuclei.

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