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Research Paper

ENZYMATIC INTERACTION IN SYNTHESIS OF BIO-NANOPARTICLES

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Abstract

Nanotechnology is the most captivating area of research in the field of material science. Nanoparticles, generally considered as particles with the size of up to 100nm, exhibit completely new or enhanced properties as compared to the larger particles of the bulk material that they are composed of based on explicit characteristics such as size, distribution and morphology.Enzymes are biological molecules (proteins) that act as catalysts and help complex reactions occur everywhere in life. Enzymes accelerate, or catalyze, chemical reactions. The molecules at the beginning of the process are called substrates and the enzyme converts these into different molecules, called products. Almost all metabolic processes in the cell need enzymes in order to occur at rates fast enough to sustain life. In this mini-review I present explanation which help understand the basis of NP-enzyme interactions.The application of enzymes for the synthesis of metallic nanoparticles and for the enlargement of metallic nanoparticles is an emerging field in Nano biotechnology.

Key words: Enzymes, fungus, biosensors and nanoparticles.

INTRODUCTION

A new and emerging area in Nano biotechnology involves the use of biomaterials and, specifically, enzymes as active components for the synthesis and growth of particles. As the enlargement of the NPs dominates their spectral properties, the bio catalytic reactions that yield the nanoparticles may be sensed by the optical properties of the generated NPs. Furthermore, enzyme–metal NP conjugates may provide bio catalytic hybrid systems that act as amplifying units for bio sensing processes, and, eventually, may provide catalytic units for the generation of metallic circuitry.

Enzymes act as catalysts for the growth of metallic nanoparticles (NPs). The enzyme-mediated growth of metallic NPs provides a general means to follow bio catalyzed transformations, and to develop optical sensors for different substrates such as glucose, L-DOPA, alcohols, lactate or nerve gas analogs. Enzymes modified with Au NPs act as biocatalysts for the fabrication of metallic nanowires. The dip-pen nanolithography of NP-functionalized enzymes on Si surfaces yields bio catalytic templates that enable the orthogonal evolution of nanowires consisting of different metals.

Different oxidases generate H2O2 upon the bio catalyzed oxidation of the corresponding substrates by molecular oxygen. The generated H2O2 was found to reduce AuCl4– in the

presence of Au NP seeds that act as a catalyst. This observation led to the development of an optical detection path for glucose-oxidase activity and for the sensing of glucose [2]
Enzymatic systems such as glucose oxidase (1, 4), nitrate reductase (5), and alkaline phosphatase (6) have been successfully used to grow metal nanoparticles for the detection of analytes. Glucose oxidase (GOx), for instance, catalyzes the oxidation of β-d-glucose to d-glucono-1, 5-lactone. In the process, molecular oxygen is reduced to hydrogen peroxide (H2O2). The H2O2 produced in the GOx reaction then acts as a reductant in the presence of chloroauric acid (HAuCl4), reducing Au3+(aq) to Au0(s), which deposits on the surface of gold "seed" particles in solution. This change in particle size leads to anincrease in the optical extinction of the particles in solution arising from a combination of the absorption and scattering from the particles in solution.
The enzyme assays indicated the role of enzyme as a reducing and shape directing agent in synthesis of nanoparticles. Different strains of fungus can be used for enzymatic synthesis of metallic nanoparticles. Enzyme like lignin peroxidase, Laccase was the dominating enzyme in the case of fungal media for the synthesis of metallic nanoparticles.
Interest in magnetic biosensing has grown tremendously over the past decade. Magnetic nanoparticles (MNPs), commonly used in sample capture, clean-up, and concentration, are also now evaluated as labels for sensitive biomolecule detection [8] since they are unaffected by photobleaching or turbidity, and magnetic background is ubiquitously absent even from the most complex biological samples. The application of giant magnetoresistive (GMR) sensors and MNP labels to bioassays and diagnostics was first suggested by Baselt et al. in 1998 [9], and by Shieh and Ackley in 2000 [10]. This approach is attractive because of the solid-state and potentially low-cost nature of the sensors, and the absence of concerns associated with photobleaching, scattering, and fouling.
The lignolytic fungi, Phanerochaete chrysosporium has been the most intensively studied white rot fungus and is considered as a model strain for the development and understanding of the lignolytic-enzyme-production system as it can produce more complete lig- nolytic enzyme complex than most other strains. But surprisingly this particular strain of fungus has not been much explored for the biosynthesis of gold NPs. Although, in 2006 Vigneshwaran [14] reported the biosynthesis of silver nanoparticles using fungus Phaenerochaete chrysosporium, so they explored the utilization of this model strain Phaenerochaete chrysosporium for the biosynthesis of gold NPs under varied working conditions. Working towards an ecofriendly, simple yet speedy approach they have developed a one step, easy, cheap and convenient method for the biosynthesis of gold nanoparticles using white rot fungus, Phaenerochaete chrysosporium.
Biomaterials and biological structures of higher complexity may act as active units for the synthesis of nanoparticles. The exposure of the fungus Verticillium sp. to an aqueous solution of AuCl resulted in the reduction of the salt to gold nanopar-ticles with diameters of ca. 20 nm. The nanoparticles were formed on the cell surface as well as intracellular [15]Silver single crystals with defined shapes, such as triangles or hexagons, were generated in the Pseudomonas stutzeri AG259 bacteria in the presence of AgNO3[16]Similarly, the fungus Tri-chothecium sp., generated, in the presence of gold ions,spherical, rod-like, and triangular morphologies of Au particles.[17]Also, cell extracts from the lemongrass plant yield, in the presence of AuCl,single-crystalline gold nanotriangles and nanoprisms.[18]

CONCLUSION

The different examples discussed in the present article have demonstrated that numerous types of enzymes, such as oxidases, hydroxylases, hydrolytic proteins, or NAD (P) +-dependent enzymes, may be employed as biocatalysts for the synthesis of metal nanoparticles and for the development of optical/electrochemical sensors for the respective substrates.
Although the present review has emphasized the enzymatic interaction with metallic NPs, this concept may be extended tothe bio catalyzed synthesis of other materials such as semiconductor NPs (e.g., CdS, PbS) or magnetic NPs.

REFERENCES

1. Willner, I.; Baron, R.; Willner, B. Adv. Mater. 2006, 18, 1109– 1120.
2. M. Zayats, R. Baron, I. Popov, I. Willner, Nano Lett. 2005, 5, 21
3. Shang, L.; Chen, H.; Deng, L.; Dong, S. Biosens. Bioelectron. 2008, 23, 1180–1184.
4. Willner, I.; Baron, R.; Willner, B. Biosens. Bioelectron. 2007, 22, 1841–1852.
5. Kumar, S. A.; Abyaneh, M. K.; Gosavi, S. W.; Kulkarni, S. K.; Pasricha, R.; Ahmad, A.; Khan, M. I. Biotechnol. Lett. 2007, 29, 439–445.
6. Basnar, B.; Weizmann, Y.; Cheglakov, Z.; Willner, I. Adv. Mater. 2006, 18, 713–718.
7. For additional experiments involving nanoparticles see Njagi, J.; Warner, J.; Andreescu, S. J. Chem Educ. 2007, 84, 1180–1182. Oliver-Hoyo, M.; Gerber, R. W. J. Chem Educ. 2007, 84, 1174–1176. Solomon, S.; Bahadori, M.; Jeyarajasingam, A. V.; Rutkowsky, S. A.; Boritz, C.; Mulfinger, L. J. Chem Educ. 2007, 84, 322–325. Dungey, K. E.; Muller, D. P.; Gunter, T. J. Chem Educ. 2005, 82, 769–770.
8. Mani, V.; Chikkaveeraiah, B.V.; Rusling, J.F. Magnetic particles in ultrasensitive biomarker protein measurements for cancer detection and monitoring. Expert Opin. Med. Diagn. 2011, 5, 381–391.
9. Baselt, D.R.; Lee, G.U.; Natesan, M.; Metzger, S.W.; Sheehan, P.E.; Colton, R.J. A biosensor based on magnetoresistance technology. Biosens. Bioelectron. 1998, 13, 731–739.
10. Shieh, R.; Ackley, D.E. Magnetoresistance-Based Method and Apparatus for Molecular Detection. WO 1997045740 A1, 4 December 1997.
11. Li, Y.; Srinivasan, B.; Jing, Y.; Yao, X.; Hugger, M.A.; Wang, J.P.; Xing, C. Nanomagnetic competition assay for low-abundance protein biomarker quantification in unprocessed human sera. J. Am. Chem. Soc. 2010, 132, 4388–4392.
12. Srinivasan, B.; Li, Y.; Jing, Y.; Xu, Y.-H.; Yao, X.; Xing, C.; Wang, J.-P. A detection system based on giant magnetoresistive sensors and high-moment magnetic nanoparticles demonstrates zeptomole sensitivity: Potential for personalized medicine. Angew. Chem. Int. Ed. 2009, 48, 2764–2767.
13. Srinivasan, B.; Li, Y.; Jing, Y.; Xing, C.; Slaton, J.; Wang, J.-P. A three-layer competition-based giant magnetoresistive assay for direct quantification of endoglin from human urine. Anal. Chem. 2011, 83, 2996–3002
14. N. Vigneshwaran, A. A. Kathe, P. V. Varadarajan, R. P. Nachane and R. H. Balasubramanya, “Biomimetics of Silver Nanoparticles by White Rot Fungus, Phaenerochaete Chrysosporium,” Colloids Surfaces B: Biointerfaces, Vol. 53, No. 1, 2006, pp. 55-59. doi:10.1016/j.colsurfb.2006.07.014
15. P. Priyabrata, A. Ahmad, D. Mandal, S. Senapati, S. R. Sainkar, M. I. Khan, R. Ramani, R. Parischa, P. V. Ajayakumar, M. Alam, M. Sastry, R. Kumar, Angew. Chem. Int. Ed. 2001, 40, 3585.
16. T. Klaus, R. Joerger, E. Olsson, C.-G. Granqvist, Proc. Natl. Acad. Sci. USA 1999, 96, 13611.
17. A. Ahmad, S. Senapati, M. I. Khan, R. Kumar, M. Sastry, J. Biomed. Nanotech. 2005, 1, 47.
18. S. S. Shankar,A. Rai, B. Ankamwar,A. Singh, A. Ahmad, M. Sastry, Nat. Mater. 2004, 3, 482.