Synthesis of inorganic nanomaterials by Unconventional bioelectrochemical systems and their applications

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Statement of the Problem: The biological synthesis of inorganic nanomaterials has been investigated for decades. The nanomaterials produced by biological routs were contaminated with biological origins such as exopolysaccharides, proteins, and cells, thereby limiting their applications in nanomaterial sciences due to their impurity. Recently the bioelectrochemical system (BES) has become a promising tool for recycling the energy from wastewater to generate electricity or for the recovery of metals in nanoparticle forms. The conventional BESs include two chambers (anode and cathode) separating from each other by an ion exchange membrane and an external closed circuit. The cost of the ion exchange membrane is one of the factors hindering the application of BES. The low electric current generation by BES urged researchers to find other applications of the BES such as biosensors. In this study, the unconventional BES of which the design included two separated chambers connected by an electrode rod (charcoal) (namely, non-external circuit bioelectrochemical system (nec_ BES)) was applied for the synthesis of inorganic nanoparticles (CdS, Cu, and Se) and their properties were characterized.

Methodology & Theoretical Orientation: The BES configuration included two bottle chambers separated by silicon membrane but directly connected by a charcoal electrode perforating through a silicon membrane. The electron released from Shewanella spp. at the anode was transferred to the cathode via the electrode, and the proton remained at the anode was balanced with the buffer N-(2-hydroxyethyl) piperazine-N0-2-ethane sulfonic acid (HEPES). The metal ions or thiosulfate anion in the cathode were reduced or precipitated in the form of nanoparticles. The produced nanoparticles were then characterized by scanning electron microscopy (sem), transmission electron microscopy (TEM), X-ray diffraction (XRD), UV-VIS, and antimicrobial activities.

Findings: The Shewanella-inoculating nec_BES successfully generated electron current to the cathode and produced CdS, Cu2Cl3(0H), and Se nanoparticles. The electron current was not possible to detect but the change of pH and lactate concentration confirmed the electron production in the anode. The different structures of inorganic nanomaterials were reported such as the quantum size of Ag and Se, the hollow spherical shape of CdS, and rough crystals of Cu2Cl3(OH). The crystal of Cu2Cl3(OH) demonstrated antimicrobial activities against bacterial plant pathogens.

Conclusion & Significance: The new design of BES is a cost-effective tool for the synthesis of inorganic nanomaterials. The products were clean and ready for further application in material science as well as plant pathogen controls.

Biography

Cuong Tu Ho has expertise in the microbial synthesis of inorganic nanomaterials. His study has focused on the synthesis of nanomaterials by the metal-reducing bacteria (*Shewanella spp*) and their application since 2010. In addition, he was also interested in the interdisciplinary route (chemical, sonochemical, biological, and physical) for synthesizing and crystallizing inorganic nanomaterials.

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