

Immobilized enzyme cascade for the synthesis of polyaniline

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Abstract:

Polyaniline (PANI) is an intrinsically conductive polymer with significant applications, such as in drug delivery, microelectronics, photovoltaic cells, plastic batteries, display devices, and chemical electrodes. PANI is typically synthesized through chemical or electrochemical oxidation polymerization of the ANI monomer. However, these methods have notable drawbacks, including harsh synthesis conditions such as extreme pH levels, high temperatures, strong oxidants, and toxic solvents. An alternative is the enzymatic polymerization of ANI using oxidoreductases, which offers milder and more environmentally friendly conditions. The most commonly used enzyme for this is horseradish peroxidase (HRP) in the presence of H_2O_2 . However, HRP inactivation occurs at high oxidant concentrations. This issue can reportedly be mitigated by generating H_2O_2 in situ from D-glucose using a bienzymatic cascade of free, non-immobilized glucose oxidase (GOx) and HRP. In the present study, PANI synthesis was achieved through the GOx/HRP bienzyme cascade after its non-covalent immobilization onto magnetic-sensitive polyamide (PA) microparticles (e.g., PA4, PA6, and PA12). HRP and GOx were consecutively immobilized onto each carrier. The resulting hybrid PA@GOx/HRP biocatalysts, along with the free-standing GOx/HRP system, were comparatively evaluated for immobilization efficiency and catalytic activity. All hybrid biocatalysts were successfully applied in the polymerization of ANI without the need for a template. The PANI-coated polyamide microparticles were subsequently isolated and preliminarily characterized, and their possible applications were evaluated.