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A continuous fluidic bioreactor utilising electrodeposited silica for lipase immobilisation onto nanoporous gold

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Keywords: lipase; electrodeposition; nanoporous gold; enzyme immobilisation; flow cell; microfluidic enzymatic reactor

Abstract

An electrochemically triggered sol-gel process was used to generate a thin silica layer for the immobilisation of lipase from *Thermomyces lanuginosus* onto dealloyed nanoporous gold (NPG). The catalytic response of the entrapped lipase was examined using the hydrolysis of 4-nitrophenyl butyrate (4-NPB) as a model reaction. For the electrodeposition process, parameters including the deposition time and the concentration of lipase affected the observed catalytic activity. A deposition time of 180 s and a lipase concentration of 3 mg/mL was used to prepare the optimised electrode. The operational stability of the silica immobilised enzyme was enhanced on NPG in comparison to that on planar gold, which may arise from confinement of the enzyme in the porous structure. The modified electrodes were incorporated into a 3D printed flow cell with conversion efficiencies of up to 100% after 8 cycles.

1. Introduction

Immobilised enzymes [1] have been successfully used in applications such as biocatalysis [2, 3], biosensors [4] and biofuel cells [5-7]. Silicate materials including controlled pore glass (CPG), sol-gel derived silicate and mesoporous silicate (MPS) are biocompatible and widely used as solid supports for the immobilisation of enzymes [8]. Sol-gel derived silicate materials possess features that include ease of preparation, chemical inertness, negligible swelling and optical transparency [9]. In addition, the sol-gel process enables enzymes to be immobilised without significant losses in activity [10]. Electrodeposition provides a