Abstract

This paper reports the signal-guided sequential assembly of labile nano-bio-components onto specific assembly sites inside a completely packaged microfluidic environment. We demonstrate (a) programmable assembly of biologically active green fluorescence protein (GFP) and (b) microfluidic environment. We demonstrate (a) programmable assembly bio-components onto specific assembly sites inside a completely packaged microfluidic device.

Method

Nanobio-components assembly

- Biofunctionalization in prefabricated microfluidic devices
- Spatially and temporally controlled chitosan electrodeposition
- Sequential assembly of nanobio-components onto chitosan scaffold

Prefabricated microfluidic device

Sequential DNA Hybridization

Experimental process:

- First, chitosan solution was introduced into a microchannel and electrodeposited on a selected electrode.
- Second, glutaraldehyde was introduced to activate the electrodeposited chitosan.
- Next, probe single string DNA (ssDNA) was introduced to be assembled onto the scaffold.
- Then a mismatched ssDNA is introduced into the microchannel.
- Finally, a matched target ssDNA is introduced to hybridize onto the probe ssDNA.

Results:

- Matched ssDNA complementarily hybridized to probe ssDNA on chitosan scaffold
- The hybridization saturated within 15 minutes

Programmable Protein Assembly

Experimental process:

- Electric signal guides chitosan assembly (spatial and temporal).
- Tyrosinase activates the pro-tag on GFP for covalent binding onto chitosan.

Results:

- Experiment: GFP covalently bonds to spatially selective chitosan scaffold, thus withstands PBS rinsing.
- Control: GFP is nonspecifically associates with chitosan, thus is easily rinsed away.

Conclusions:

- Simple, robust and versatile biofunctionalization strategy
- Sequential assembly of labile proteins and DNA in microfluidic devices
- Spatial and temporal programmability of biomolecule assembly

Applications:

- The signal-guided programmability is attractive for multi-site/multi-step bioreactions in metabolic engineering and other bioMEMS applications.

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