Colloids and Surfaces A: Physicochem. Eng. Aspects 414 (2012) 384–392

Contents lists available at SciVerse ScienceDirect

Colloids and Surfaces A: Physicochemical and Engineering Aspects

journal homepage: www.elsevier.com/locate/colsurfa

Fabrication of dense, uniform aminosilane monolayers: A platform for protein or ligand immobilization

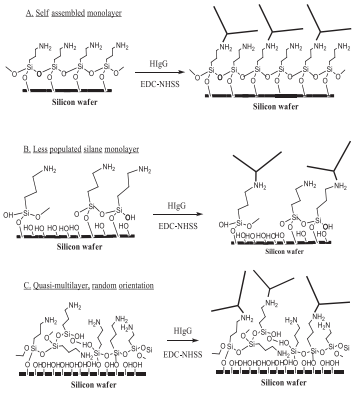
Sanjukta Guha Thakurta, Anuradha Subramanian*

Department of Chemical and Biomolecular Engineering, University of Nebraska-Lincoln, United States

HIGHLIGHTS

- Study aimed at designing surfaces to achieve uniform and high biomolecule binding.
- We correlated silanization reaction parameters with protein binding efficiency.
- Achieved uniform and dense silane monolayer as biomolecule immobilization template.
- Human IgG was covalently immobilized on prepared silanized surfaces.
- We reported silanization reaction parameters that yielded maximum protein binding.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 14 May 2012
Received in revised form 11 August 2012
Accepted 21 August 2012
Available online 30 August 2012

Keywords:
Biosensor
Silanization
3-Aminopropyltriethoxysilane
Self-assembled monolayer
Surface characterization
Surface topography
Antibody conjugation

ABSTRACT

Designing biointerfaces with enhanced biomolecule binding abilities, along with their distribution and presentation on the surface, largely requires control over underlying surface chemistries. In an effort to correlate experimental parameters to surface properties, ligand distribution and biomolecule binding, the influence of (3-aminopropyl)triethoxysilane (APTES) concentration (1, 2 and 4 vol%) and duration of the silanization reaction (5–60 min) on the number of available $-NH_2$ groups were determined and correlated with the amount of surface bound human immunoglobulin G (HIgG). Surfaces silanized with 2 vol% APTES for 30 min yielded a densely populated silane monolayer (1.0–1.2 nm) where the average molecular orientation was $38 \pm 2^{\circ}$ with respect to the surface normal. A surface density of $-NH_2$ moieties of $\sim 10^{15}/cm^2$ was obtained and was significantly higher compared to other conditions evaluated. The combined data from ellipsometry and atomic force microscopy (AFM) analyses supports our findings. Coupling of HIgG to surfaces silanized with 2 vol% APTES for 30 min yielded $\sim 10^{13}$ IgG/cm^2, which was significantly higher than values obtained at 1 vol% APTES for 30 min. The distribution of immobilized HIgG was noted to be dense and uniform on surfaces silanized with 2 vol% APTES when visualized using Nanogold® antibody conjugates. This study highlights the critical role of the experimental parameters that impact the biomolecule immobilization process on functionalized surfaces.

Published by Elsevier B.V.

1. Introduction

Sensing platforms that utilize functionalized surfaces have aided the study of complex biological reactions [1–4]. The design and fabrication of functionalized surfaces for the selective adsorption of

* Corresponding author. Tel.: +1 402 472 3463; fax: +1 402 472 6989.
E-mail address: asubramanian2@unl.edu (A. Subramanian).

0927-7757/$ – see front matter. Published by Elsevier B.V.
http://dx.doi.org/10.1016/j.colsurfa.2012.08.049