Bioengineering of Metals with OptoDex® S

H. Gao, S. Guinchard, F. Crevoisier, I. Caelen•, H. Sigrist

A unique application of the novel photolinker polymer OptoDex® S extends the generic process of light-dependent covalent functionalization of material surfaces to sulfur reactive metal substrates, in particular to gold surfaces. The approach enables chemisorption and subsequent photochemical functionalization of highly paralleled bioanalytical platforms as well as passivation of analytical and medical devices.

Attachment of particles, polymers, biomolecules and inorganic assemblies to metals or metal-coated surfaces becomes feasible with linker chemistries, able to establish molecular bonds between probing targets and the material substrate[1]. The requirements are met with OptoDex® S. The novel polymer has been successfully synthesized and characterized as multiple and bi-functional substituted dextran-based polymer. OptoDex® S contains both sulfur-containing substitutents and chemical functional groups that convert to highly reactive intermediates when activated with actinic energy (+ Light; controls without light activation: – Light). (Table 1 and 2).

Samples	Thiol groups (pmol / well)	
	+ Light	– Light
OptoDex® S	29.8 ± 4.9	4.2 ± 2.3
OptoDex® A	5.5 ± 0.40	2.3 ± 2.2

Table 1: Determination of thiol groups of photoimmobilized OptoDex® S.

	Surface contents	Assay condition	Alk. Phosphatase activity (E405 nm)
Sample	OptoDex® S & Alk. Phosphatase	+ Light	2.333
		– Light	0.058
Control 1	OptoDex® A & Alk. Phosphatase	+ Light	2.256
		– Light	0.064
Control 2	OptoDex® S	+ Light	0.055

Table 2: The photoactivity of OptoDex® S is tested by light-dependent, carbene mediated immobilization of alkaline phosphatase onto polystyrene, using OptoDex® S as photolinker polymer. Light-dependent binding is observed by measuring the enzymatic activity of photoimmobilized alkaline phosphatase.

The second part of the study concerns the process and the product of surface engineering with OptoDex® S. Direct metal surface functionalization with OptoDex® S by chemisorption (sulfur - metal interaction) generates hydrophilic and photoactive surfaces without the need of a barrier layer. The novel surface has been tested with different probe molecules and different material substrates. Furthermore, the conditions of latent photoactive group activation have been explored and the process of manufacturing analytical platforms and devices has been established (Fig. 1).

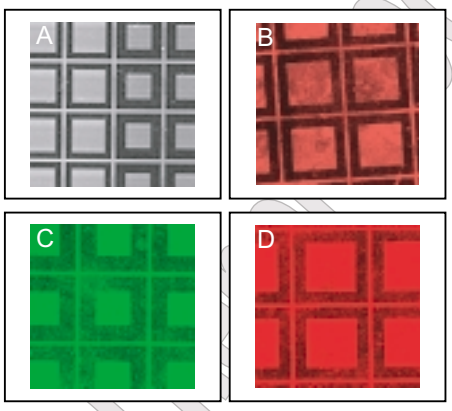

Figure 1: Photo-patterned biomolecules on gold. Figure 1a shows the design of the mask used for photo-patterning as highlighted in figure 1b, 1c and 1d. The mask reveals two different light-absorbing structures. Figure 1B and 1C show images of Cy5-labeled riboflavin binding protein and Cy3-labeled bovine serum albumin, respectively; both after immobilization on OptoDex® S modified gold surfaces. Figure 1d shows an image of photopatterned (not fluorescent) m-IgG, after immunocomplexation with Cy5-labeled goat anti-mouse IgG antibody all detected by scanning of Cy5 fluorescence.

An application of the technology is exemplified in the third part of the investigation. Light-induced immobilization of the riboflavin binding protein is applied to an OptoDex® S treated gold platform. The sensogram (Fig. 2) depicts the time course of vitamin B_2 binding to the photoimmobilized receptor protein as probed in a plasmon resonance based bioanalytical system.

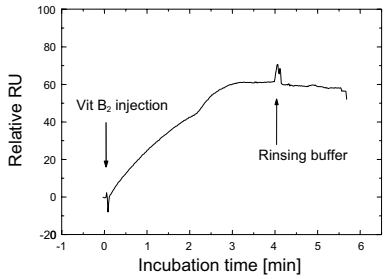

Figure 2: Surface plasmon resonance sensogram of vitamin B_2 binding to riboflavin binding protein after its photoimmobilization on an OptoDex® S modified gold platform.

OptoDex® S is a new member of the OptoDex® family. Its versatile application potential, its facile use and the unique interphase characteristics on sulfur reactive metals make OptoDex® S a distinguished tool for biosensors and microarray technologies.

The project partners is Nestlé Research Center, Nestec Ltd. Lausanne, Switzerland.

• Nestlé Research Center, Lausanne

[1] H. Gao, S. Guinchard, F. Crevoisier, S. Angeloni, H. Sigrist, Chimia 57 (2003) 651