Optodex as a Linker to Functionalize Textiles

H. Gao, D. Caminada

CSEM's versatile surface biofunctionlization technology enables creating cost effective products with outstanding performance and stability. CSEM's patented linker polymer OptoDex® and related surface functionalization technologies cover a large scope of applications: from robust bioanalytics for in vitro diagnostics to biofunctionalization of implant surfaces and medical devices. OptoDex® immobilizes almost any biomolecule, in particular proteins, on an exceptionally large range of material surfaces. One single OptoDex® linker polymer provides up to 6 reactive sites, capable of establishing covalent bonds with the surface, the biomolecule or other OptoDex® polymers.

Wound healing is a complex process encompassing a number of overlapping phases, including inflammation, epithelization, granulation tissue formation and tissue remodelling. The OptoDex® technology comprises widely applicable validated processes and procedures for bio- and nano-engineering of solid and soft surfaces. Covalent attachment of (bio) molecules to any type of surface is attained with carbene-based linker chemistries. Carbenes are highly reactive intermediates. Photochemically or thermochemically generated polymer-based carbenes act as molecular glue when brought into contact with, and activated in the presence of both target material and target (bio)molecules.

The covalent functionalization of textile for wound care dressings has been developed at CSEM using OptoDex®—an in-house surface bioengineering technology. Bio-functional molecules are covalently immobilized on textile surfaces while maintaining their specific activities.

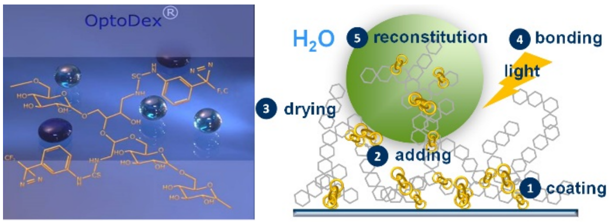

Figure 1: Schematic of the OptoDex® technology: ① Adsorptive coating of surface with photolinker polymer; ② Addition of biomolecules; ③ Stress-less vacuum drying in OptoDex® embedding; ④ Dry state bonding by photoactivated linking polymers; ⑤ Rehydration reconstitutes functional biomolecule.

The advantages and features of the OptoDex® technology for surface bioengineering are:

- One step photoactivatable (or thermo-activateable) covalent crosslinking
- Bioactivity preserving dry-state immobilization
- Surface hydrophilization and functionalization
- Robust and long-term stable biosurfaces

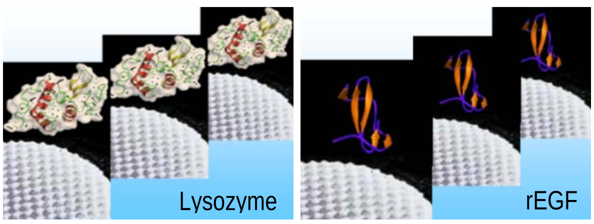

Figure 2: Biofunctionalized wound pad (polyester wound pad of Tissupor) with antimicrobial (lysozyme) or growth factor (rEGF).

In wound healing, antibacterial coatings play a crucial role. Bactericidal enzymes—lysozyme as an example—quicken the elimination of bacteria if present in open wounds. Lysozyme is a muraminidase which is widely distributed in nature. Its antibacterial activity is related to its catalytic properties by breaking the cell wall components of Gram-positive bacteria. In its polymeric state or as a dextran conjugate, lysozyme reduces antimicrobial activity for both Gram-negative and Gram-positive bacteria. The system components—textile (polyester), lysozyme and photoactivated OptoDex—are biocompatible and immobilised lysozyme is stable at room temperature for at least 5 weeks and 18 months at 4°C. The enzyme stays catalytically active after photoimmobilization and sterilization with ethylene oxide.

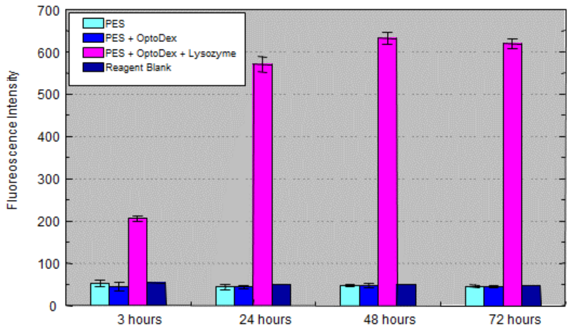

Figure 3: Lytic activity of photoimmobilised lysozyme on polyester wound pads is retained.

Besides anti-bacterial properties, the time required for complete wound healing, and the efficiency of the individual steps involved are crucial. With many overlapping functional properties, epidermal growth factor (EGF) orchestrates the recruitment and growth of fibroblasts, such as molecular presentation and its resulting cellular effects, termed matricrine stimulation, mimics juxtacrine cell stimulation. Covalent attachment of recombinant human EGF (rhEGF) onto woven textile has been achieved successfully using the OptoDex surface bioengineering technology. Modified textiles can be sterilized and NRK-49F fibroblast cell proliferation is attained with OptoDex-rhEGF grafted fabrics, whereas CHO cells—as expected for not transformed CHO cells—do not elicit rhEGF-graft mediated proliferation.

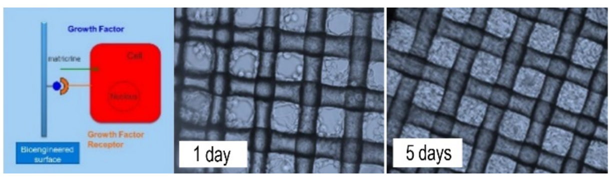

Figure 4: The images shown above document cell proliferation in the presence of a rhEGF grafted tissue scaffold. In this series of experiments, 10^6 cells were inoculated and were grown on the functionalized tissue scaffold. Images of cell culture were taken 1 day and 5 days after seeding.