DNA-Wrapped Single-Walled Carbon Nanotubes based biosensors

Oyarbide J.[1], Argarate, N.[1], Morin, F.O.[1], Pardo W. A.[2,3,4], Mir, M.[2,3], Samitier J.[2,3,4]

[1] Ciber-bbn, Tecnalia, Paseo Mikeletegi, 2, Parque Tecnológico 20009 San Sebastián, Spain. www.tecnalia.com
[2] Ciber-bbn, NANOMED -IBEC, Instituto de Bioingeniería de Cataluña (IBEC). C/ Baldiri Reixac, 13, 08028 Barcelona. www.ibecbarcelona.eu
[3] Laboratorio de Nanobioingeniería, Instituto de Bioingenieria de Cataluña (IBEC), Baldiri Reixac, 10-12, Barcelona, 08028.
[4] Departmento de Electrónica, Universidad de Barcelona (UB), Martí I Franques, 1, Barcelona, 08028

Contact: salud-024@tecnalia.com

Abstract

Deoxyribonucleic acid (DNA) biosensors, which employ an immobilized DNA as the biological recognition element, are currently under intense investigation due to their numerous potential applications. Among the DNA biosensors, the electrochemical DNA biosensors have been regarded to be excellent candidates for the rapid and inexpensive diagnosis of biological species of clinical interest, and for the compatibility with microfabrication technology [1,2]. In the last years, DNA functionalization of CNTs has attracted attention in various fields such as nucleic acid sensing and controlled deposition on semiconducting or conducting substrates [3]. This fact is due to the combination of the unique properties of the CNTs and the outstanding recognition capabilities of DNA [4].

In this sense, this work reports an optimized strategy for the wrapping of a specific DNA with and without a 5`SH-poly$(GT)_{10}$ sequence labeled with a fluorescence group onto HNO_3 treated Nanocyl 90 SWCNTs. This method is a relatively simple procedure that produces a strong π-π interaction between DNA (GT) strands and CNTs [5]. So, this functionalization does not disrupt the mechanical and electronic properties of the CNTs [6]. DNA-CNT hybrids were characterized by spectroscopic methods and measurement of the diameter change of SWCNT without or with DNA by AFM. Finally, we studied the possibility of using CNT-DNA hybrids in the fabrication of biosensors for selective recognition of DNA. Different biosensor configurations were tested with surface plasmon resonance (SPR), transmission electron microscope and atomic force microscope in order to select the most efficient and selective strategy for DNA detection. In conclusion, suitable CNT-DNA wrapping and surface protection procedure has been established for the design of a DNA-wrapped SWCNT based biosensor.

References

[1] S.G. Wanga, Ruili Wang, P.J. Sellina, Qing Zhang. Biochemical and Biophysical Research Communications, **4**, (2004) 1433–1437.

[2] Ignác Capek. Dispersions Based on Carbon Nanotubes – Biomolecules Conjugates**,** Carbon Nanotubes- Growth and Applications, (2011) Dr. Mohammad Naraghi (Ed.), ISBN: 978-953-307-566-2, InTech.

[3] Sobhi Daniela, Talasila Prasada Raoa, Kota Sreenivasa Raob, Sikhakolli Usha Ranib, G.R.K. Naiduc, Hea-Yeon Leeb, Tomoji Kawai, G.R.K. Naiduc, Hea-Yeon Leeb and Tomoji Kawai, Sensors and Actuators B, **122** (2007) 672–682.

[4] Sanchez-Pomales, G., Pagan-Miranda, C., Santiago-Rodriguez, L., Cabrera, C. R. Carbon Nanotubes, (2010). Jose Mauricio Marulanda (Ed.), ISBN: 978-953-307-054-4.

[5] Cao, Cet al., Materials Chemistry and Physiscs, **112,** (2008) 738-741;

[6] Sánchez-Pomales, G., Cabrera, C.R., Journal of Electroanalytical Chemistry, **606,** (2007) 47-54.

Figures:

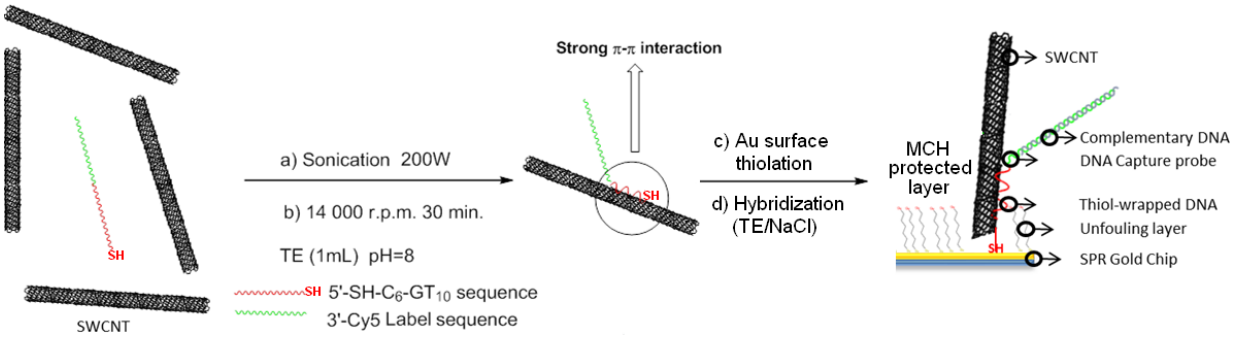

Figure 1. Schematic representation of wrapping procedure and the design of a DNA-SWCNT based biosensor.

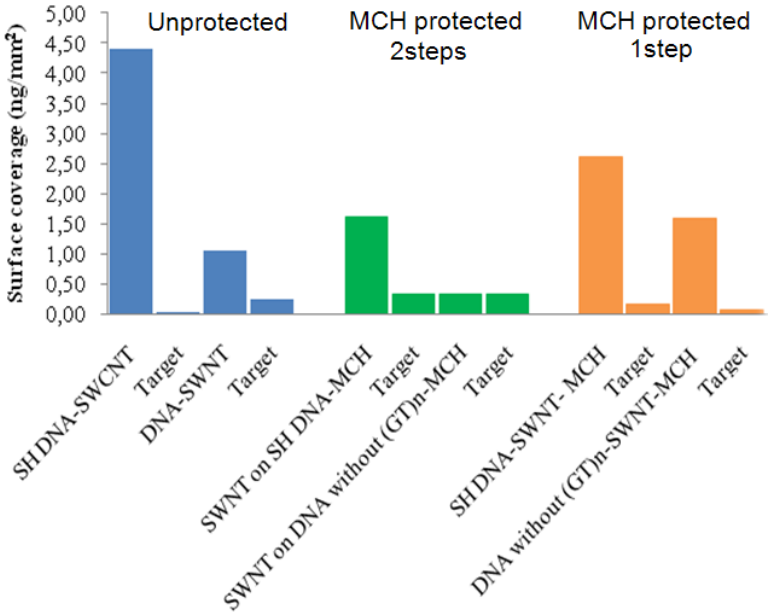

Figure 2. Surface coverage of DNA with and without thiol $(GT)_{10}$ strands, SWCNT and complementary DNA (Target) for the different systems by Surface Plasmon Resonance (SPR).

- Unprotected platform: Biosensor without unfouling layer.
- MCH protected 2 steps platform: Biosensor with a mercaptohexanol monolayer generated after the DNA-SWCNT immobilization.
- MCH protected 1 step platform: Biosensor with a mixed monolayer of mercaptohexanol and DNA-SWCNT.
- Target: DNA-SWCNT hybridized with a complementary DNA