$Ti_{1-x}Ag_x$ and Ag-TiN_x coatings deposited on PVDF substrates for sensors applications

S.M. Marques[1*], P. Rico[2,3], I. Carvalho[4], S. Lanceros-Mendez[5], M. Henriques[6], S. Carvalho[1,4]

[1]*University of Minho, Dept. Física, GRF-CFUM, Campus de Azurém, 4800-058 Guimarães*
[2]*Center for Biomaterials and Tissue Engineering, Universitat Politècnica de València, Spain*
[3]*CIBER de Bioingeniería, Biomateriales y Nanomedicina (CIBER-BBN), Valencia, Spain*
[4]*SEG-CEMUC Mechanical Engineering Department, University of Coimbra, 3030-788 Coimbra, Portugal*
[5]*Universidade do Minho, Dept./Centro de Física, Campus de Gualtar, 4700-057, Braga*
[6]*CEB - Centre of Biological Engineering, LIBRO-Laboratório de Investigação em Biofilmes Rosário Oliveira, University of Minho, 4700-057 Braga, Portugal*

Electroactive polymers are the most interesting class of polymers used as smart materials in various applications, such as the development of sensors and actuators for biomedical applications in areas as smart prosthesis, implantable biosensors and biomechanical signal monitoring, among others.
The aim of this work was the development of multifunctional coatings on a polymeric base substrate for biosensor applications. The coatings were deposited by magnetron sputtering on polymers based sensors and the different processing conditions allowed to obtain two different systems: $Ti_{1-x}Ag_x$ with different Ag/Ti atomic ratio and different Ag-TiN_x samples with increasing N content. These electrodes were deposited at room temperature on poly(vinylidene fluoride), PVDF. Only on Ag-TiN_x electrodes it was possible to found Ag clusters.
Sheet resistivity values showed a typical behavior of a binary alloy system for the $Ti_{1-x}Ag_x$ series and for the Ag-TiN_x series, increasing nitrogen flow lead to lower sheet resistivity values than in the sample without nitrogen. Piezoelectricity of the different samples of $Ti_{1-x}Ag_x$ series presented similar values, but for the Ag-TiN_x series, the increase of nitrogen flow leads also to a decrease of the piezoelectric response. Despite this behavior, it was possible to conclude that the deposition conditions do not significantly affect the piezoelectric response of the polymer which maintain its suitable characteristics for sensor applications.
The mechanical and piezoresistive performance of the two series was assessed by uniaxial stretch tests and electrical resistance variation measurements during mechanical stimulus, respectively. It was possible to conclude that all electrodes show piezoresistive properties.
The antimicrobial activity of samples from both series was assessed by agar diffusion method (Halo test). Only the Ag-TiN_x series presented antibacterial activity, promoted by the Ag clusters. Osteogenesis was also evaluated using MC3T3 osteoblastic cells. The results indicated lower cells attachment on the Ag-TiN_x electrodes compared with the $Ti_{1-x}Ag_x$ electrodes. The same behavior was observed for proliferation and differentiation tests.
So, as main conclusion, a multifunctional electrode was achieved with antibacterial activity, which at an early stage does not promote animal cells adhesion and it still has proper electrical and mechanical properties. Further, it preserves the piezoelectric response of the polymer when deposited on PVDF and shows itself suitable and useful piezoresistive response for sensor applications.

Presenting author: Sandra M. Marques, *Universidade do Minho, Dept. Física, GRF-CFUM, Campus de Azurém, 4800-058 Guimarães, Portugal*, mariana.marques@fisica.uminho.pt