Gold electrodes functionalized with silver nanoparticles: an original and promising route for nitrate sensing in seawater.

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Abstract

Nitrate is an essential plant nutrient and its concentration exerts a primary control on phytoplankton biomass and growth rates in the ocean. Historically, the concentration of nitrate has been determined by reagent-based chemical analysis in samples returned to shipboard or shore-based laboratories [1]. Moreover, traditional bench-top nitrate-analysis procedures, based on UV/Vis spectrometry, gas, ion and liquid chromatography, or capillary electrophoresis, usually requires expensive and massive instrumentation, and complex measurement procedures [2,3]. Thus these techniques are not well adapted for continuous and onsite oceanic analysis. To monitor nitrate concentration, *in situ*, real-time, low-power consuming, sensitive, selective and stable nitrate sensors must be developed.

Electrochemistry methods are promising as they are sufficiently sensitive, relatively simple to operate, easy to miniaturize, and less power-demanding. A wide variety of systems have been developed, most of them using bare metal electrodes [3,4]. However, the use of bare unmodified electrodes for direct determination of nitrates is difficult because of the slow kinetics of the charge transfer step, dependent on several parameters (pH, interference of dissolved oxygen, etc.).

We present here an original electrochemical strategy for nitrate sensing in artificial seawater at relatively neutral pH (~6). A gold disk electrode was functionalized with silver nanoparticles (AgNPs) resulting from the decomposition of a silver metal-organic precursor in solution. This synergetic approach combines the advantages of the gold electrode surface and the presence of AgNPs (Figure 1) [5,6]. The results obtained for different synthetic NO_3^- solutions at neutral pH using AgNPs modified-gold electrodes will be discussed and compared to the performance of gold and silver electrodes.

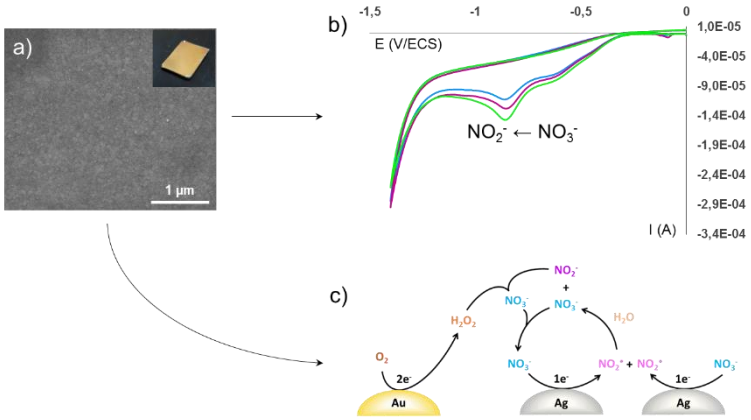

Fig.1. a) SEM image of the functionalized gold electrodes with AgNPs ;
b) Cyclic voltammogram of nitrate reduction 10^{-4}-10^{-6} mol.L^{-1} ;
c) Mechanism of the electroreduction of NO_3^- ions on modified electrode

References

[1] K. S. Johnson et al., J. of Atmospheric and oceanic technology, **30** (2013) 1854.
[2] D. Kim et al., Analyst, **132** (2007) 350.
[3] J.M.J. Moorcroft et al., Talanta, **54** (2001) 785.
[4] J.C.M. Gamboa et al., Talanta, **80** (2009) 581.
[5] K. Fajerwerg et al., Electrochemistry Communication, **12** (2010) 1439.
[6] M. T. M. Kopper et al., Phys. Chem. Chem. Phys., **15** (2013) 3196.