Direct electrochemical detection of gold nanoparticles: application in magnetobiosensors

Alfredo de la Escosura-Muñiz [1,2], *Adriano Ambrosi* [2], *Marisa Máltez* [2], *Arben Merkoçi* [2]
[1] *Instituto de Nanociencia de Aragón, Universidad de Zaragoza, Zaragoza, Spain*
[2] *Institut Català de Nanotecnologia, Campus UAB, Barcelona, Spain*
alfredo.escosura.icn@uab.es

Nanobiotechnology can be defined as the branch of nanotechnology that uses its tools, components and processes for biosystem studies and applications. It is an interdisciplinary field, that integrates physical sciences, molecular engineering, biology, chemistry and biotechnology.

The development of nanobiosensors is one of the main research areas of nanobiotehcnology. In this context, electrochemical biosensors based on the use of nanoparticles (NPs) as electroactive labels offer several advantages in terms of sensitivity, selectivity, cost and time of analysis, etc. compared with the traditional methods of bioanalysis, such as ELISA or PCR.

Gold nanoparticles (AuNPs) stand out from the variety of nanoparticles used as labels in biosensing, due to their simple synthesis, narrow size distribution, optical and electrochemical properties and easy bioconjugation. These advantageous properties have given rise to an explosive growth of AuNP-based immuno and DNA electrochemical assays in the last years. The vast majority of these electrochemical methods have been based on chemical dissolution of AuNPs in a hydrobromic acid/bromine mixture followed by accumulation and stripping analysis of the resulting Au^{3+} solution. The HBr/Br_2 solution is highly toxic and therefore methods based on direct electrochemical detection of AuNPs tags, which would replace the chemical oxidation agent, are needed.

In the present work, a direct electrochemical detection route for detect AuNPs, without previous dissolving is used. This route consists in the in-situ electrochemical oxidation of AuNPs to $AuCl_4^-$ on the electrode surface, followed by immediate electro-reduction and registering the reduction process current [1]. This AuNPs detection strategy is approached for the determination of DNA [2] and proteins [3] in magnetobioassays, using micromagnetic beads (MBs) as support of the bioassays, and AuNPs as labels. These biosensors take advantage of the properties of the MBs as platforms for the bioreactions, in terms of selectivity and time of analysis, together with the electro-detection inherent advantages.

The developed biosensors are instrumentally simple to use, with low cost and portable instrumentation, and the samples volumes required are lower than those used in the traditional methods. The low levels of AuNPs detected with the electrochemical method allow the obtaining of biosensors with low protein and ss-DNA target detection limits, with special interest for further applications in clinical analysis, food quality and safety as well as other industrial applications.

References:

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