Use of novel bimetallic nanoparticles as labels in biosensing for applications in clinical diagnostics

Alfredo de la Escosura-Muñiz
NanoBioAnalysis Group-Department of Physical and Analytical Chemistry, University of Oviedo, Oviedo, Spain
alfredo.escosura@uniovi.es

The use of metal nanoparticles has been a breakthrough since they were first synthesized and implemented into different research topics with continuous progress. Biosensing is among the main areas of application, in which the usage of such nanoparticles has implied a significant improvement. Their unique properties, including electron transfer, biocompatibility and electroactive and electrocatalytic activity, among others, has enabled decreasing detection limits and increasing sensitivity, selectivity and reproducibility of the assays. Their use as both colorimetric and electrochemical labels in immunosensing has been deeply studied, constituting an outstanding alternative to traditionally used enzymes.

Bimetallic nanoparticles have recently emerged as advantageous alternative to the monometallic ones. The presence of two metals in the nanoparticle surface allows to take advantage of the individual properties of each metal. Moreover, some nanoparticle properties are typically enhanced due to synergies between both metals.

In this context, in this communication are presented recent works exploiting the use of novel Pt-Au and Pd-Au nanoparticles (NPs) as tags in biosensing for clinical diagnostic applications.

The bimetallic Pt-Au NPs proposed have a core@shell morphology, with a final platinum surface covered by gold protuberances giving a raspberry shape. The gold surface allows to immobilize antibodies while the platinum surface contributes with an outstanding electrocatalytic activity, which is applied in electrochemical immunosensing [1,2]. Moreover, the core@shell structure exhibits eletrochemiluminescence properties that are also applied in immunosensing [3]. Finally, the high functionality of such NPs, together with the strong violet color is also ideal for their use as tags in lateral flow immunoassays, showing clear advantages compared with traditional AuNPs.

On the other hand, in the case of the bimetallic Pd-Au NPs, the role that slight changes into the Pd/Au proportion have in their electrocatalytic activity is studied for the first time, together with their application as novel tags in immunosensing [4]. The selective introduction of gold atoms on the palladium nanocluster, following a galvanic substitution procedure, is quantitatively evaluated by STEM-EDX analysis. Our findings indicate that the synergy between both metals is strongly enhanced when the amount of gold is controlled and occupies the more reactive positions of the cluster, affecting the obtained electrocatalytic activity. This is of key relevance, since it is observed that an excess of gold leads to a decrease in such activity. These findings may be of great interest not only for biosensing, but also for applications such as energy converting on fuel cells.

The advantageous bimetallic nanoparticles-based biosensing systems are applied for the detection of biomarkers of diseases like Alzheimer's [1], COVID-19 [2,3] or chronic wound infections [4] in real samples, paving the way to novel clinical diagnostic systems.

References

[1] A. Iglesias-Mayor et al. *Anal. Chem*., 92 (2020) 7209.
[2] E. Martínez-Periñán et al. *Talanta*, 280 (2024) 126708.
[3] A. Villa-Manso et al. *Talanta*, 260 (2023) 124614.
[4] C. Toyos-Rodríguez et al. *Biosens. Bioelectron*., 200 (2022) 113926.

Acknowledgements

The financial support of Grants MCINN-24-PID2023-149004OB-I00 and RED2022- 134120-T, funded by MCIN/AEI/ 10.13039/501100011033 and by “ERDF A way of making Europe”, and of Grant SEK-25-GRU-GIC-24-071 funded by the Asturias Regional Government, is gratefully acknowledged.