Fluorescent nanoprobes confined in a drop as a novel sensing platform for detection of metal species at trace level

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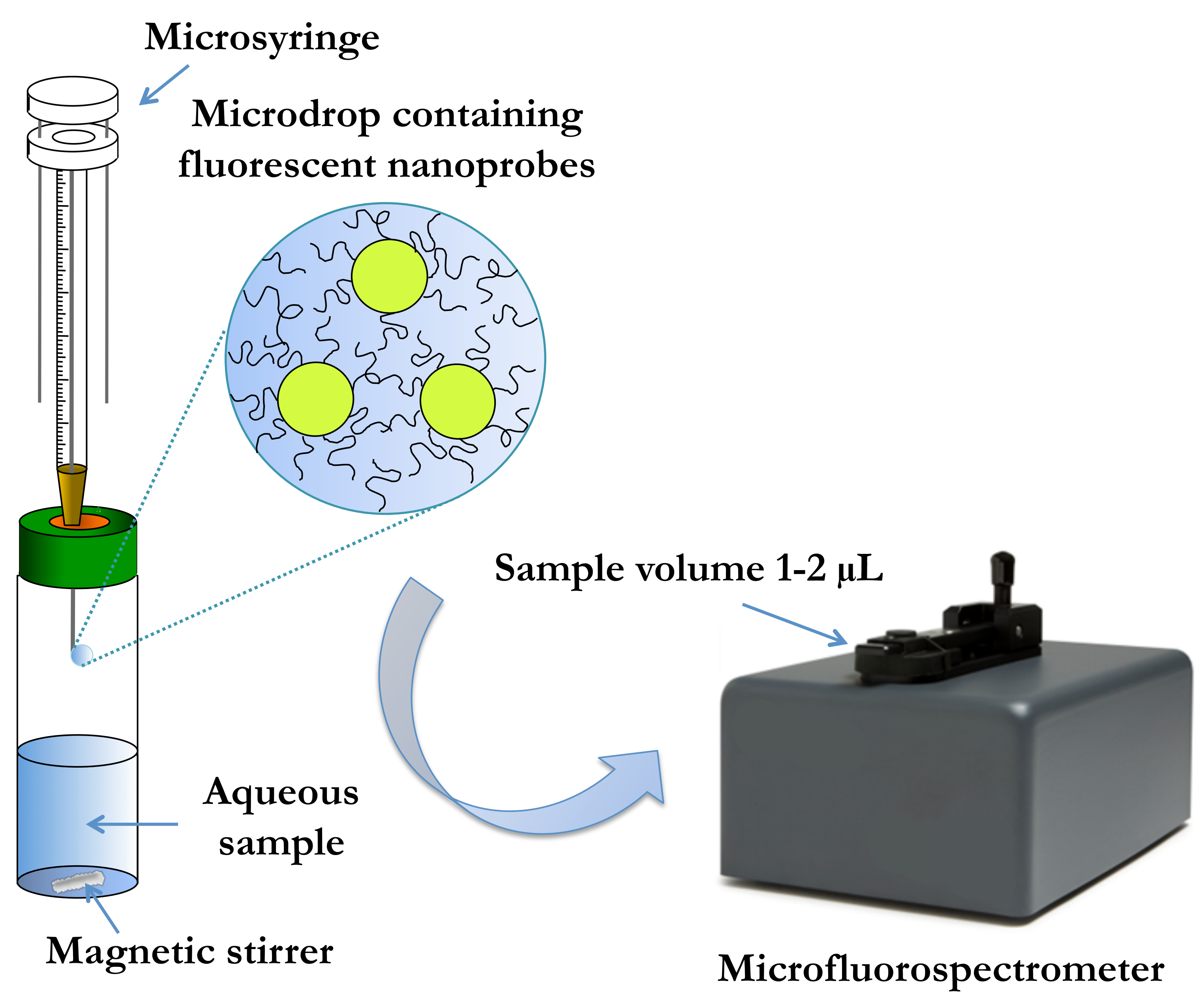
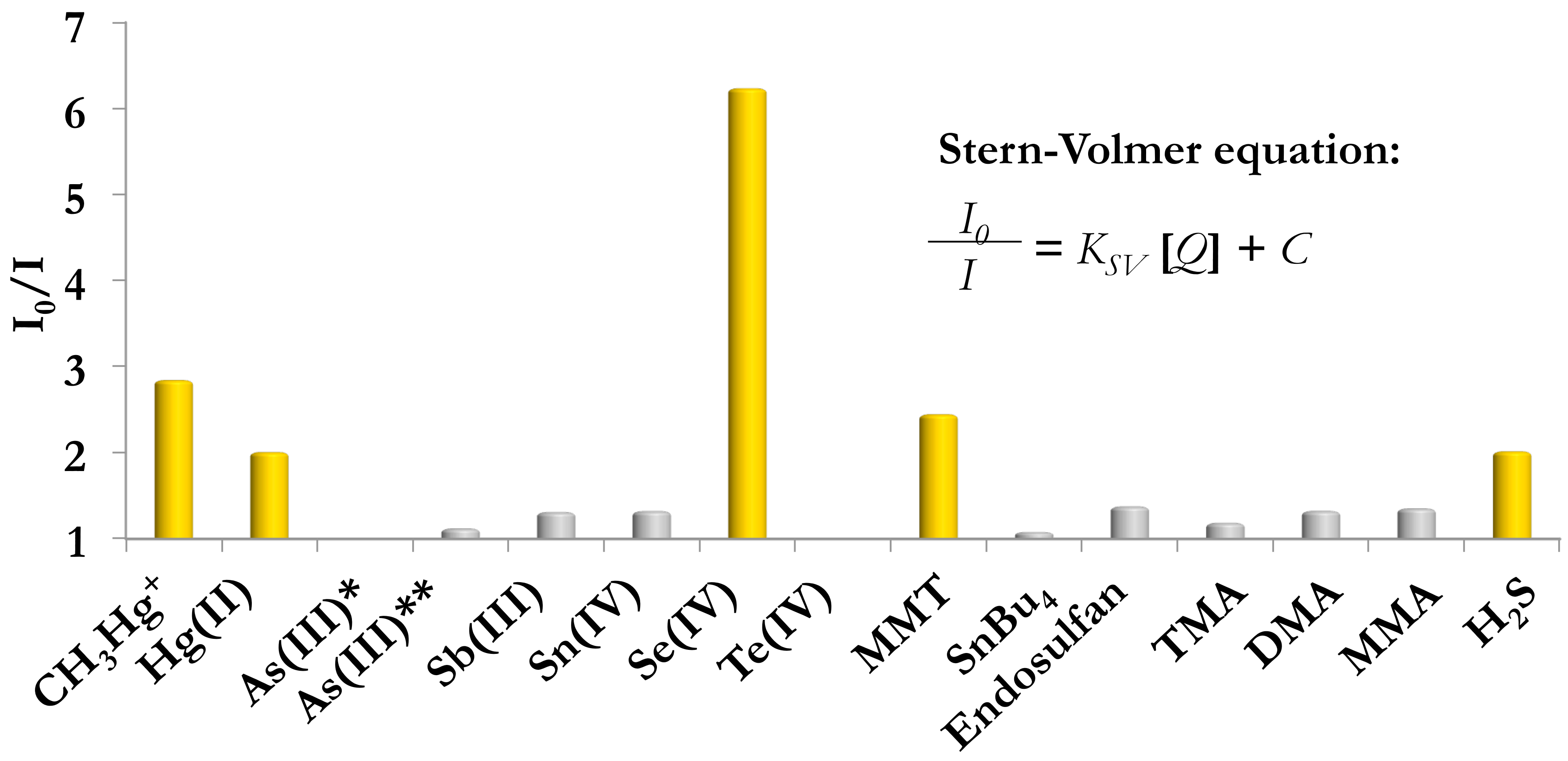
INTRODUCTION

In the last years, a great interest has arisen concerning the design and development of new optical probes for the sensitive and selective detection of chemical species making use of miniaturized and environmental friendly methods. In this sense, quantum dots (QDs) and metal nanoclusters (NCs) have important optical properties to be applied in analytical systems as fluorescent probes.

Usually, large volumes of nanoparticles are often used, which increases the environmental risk due to the presence of toxic elements in their composition as well as the analysis cost. On the other hand, one of the main drawbacks of the nanoparticle-based systems is the lack of selectivity. In this sense, the implementation of a microseparation process would provide a miniaturized system with an adequate selectivity and sensitivity to be applied to real samples analysis.



CdSe/ZnS QD-based fluorescent assay for optical sensing of volatile species



Detection limits of QDs-HS-SDME approach for sensing different species

CH_3Hg^+: 1.6×10^{-7} M

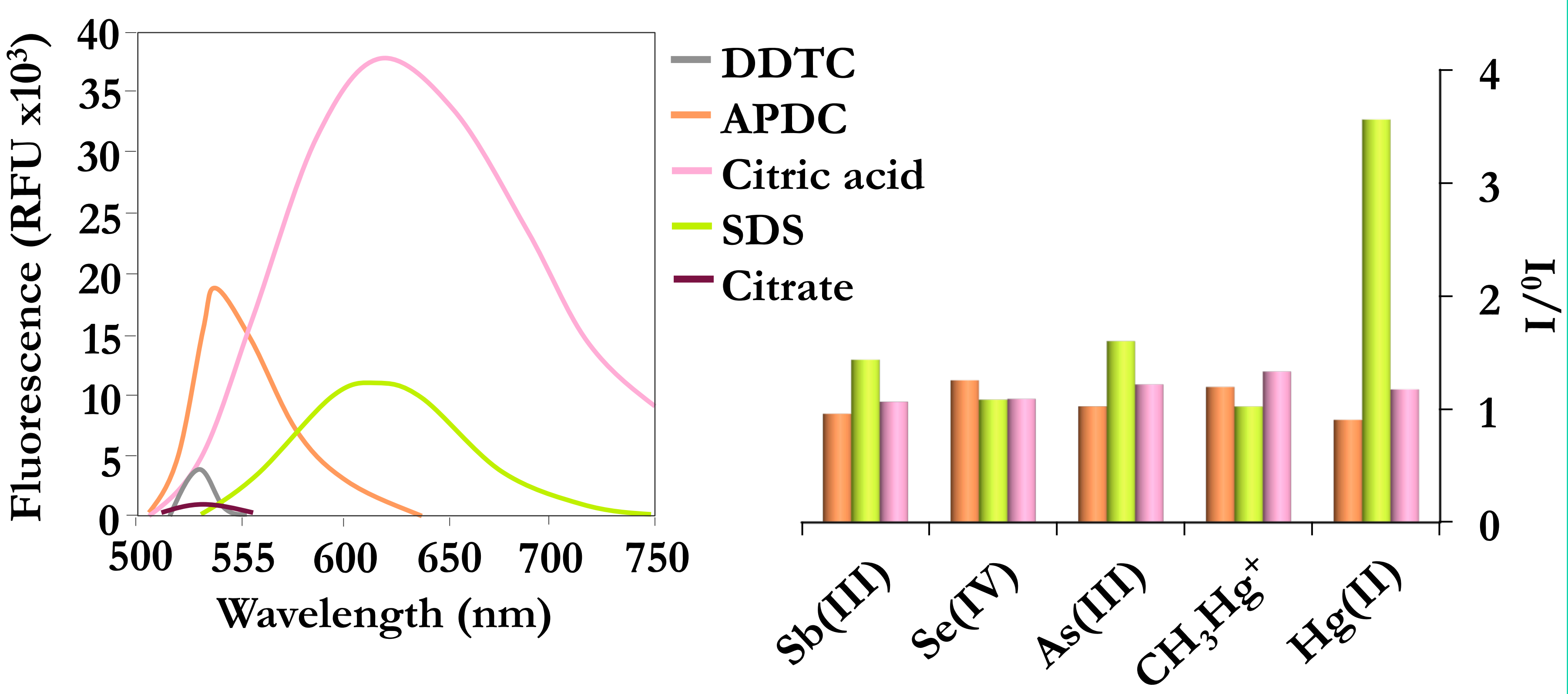
Se(IV): 6.3×10^{-9} M

Hg(II): 1.6×10^{-6} M

MMT: 1.8×10^{-6} M

H_2S: 9.4×10^{-6} M

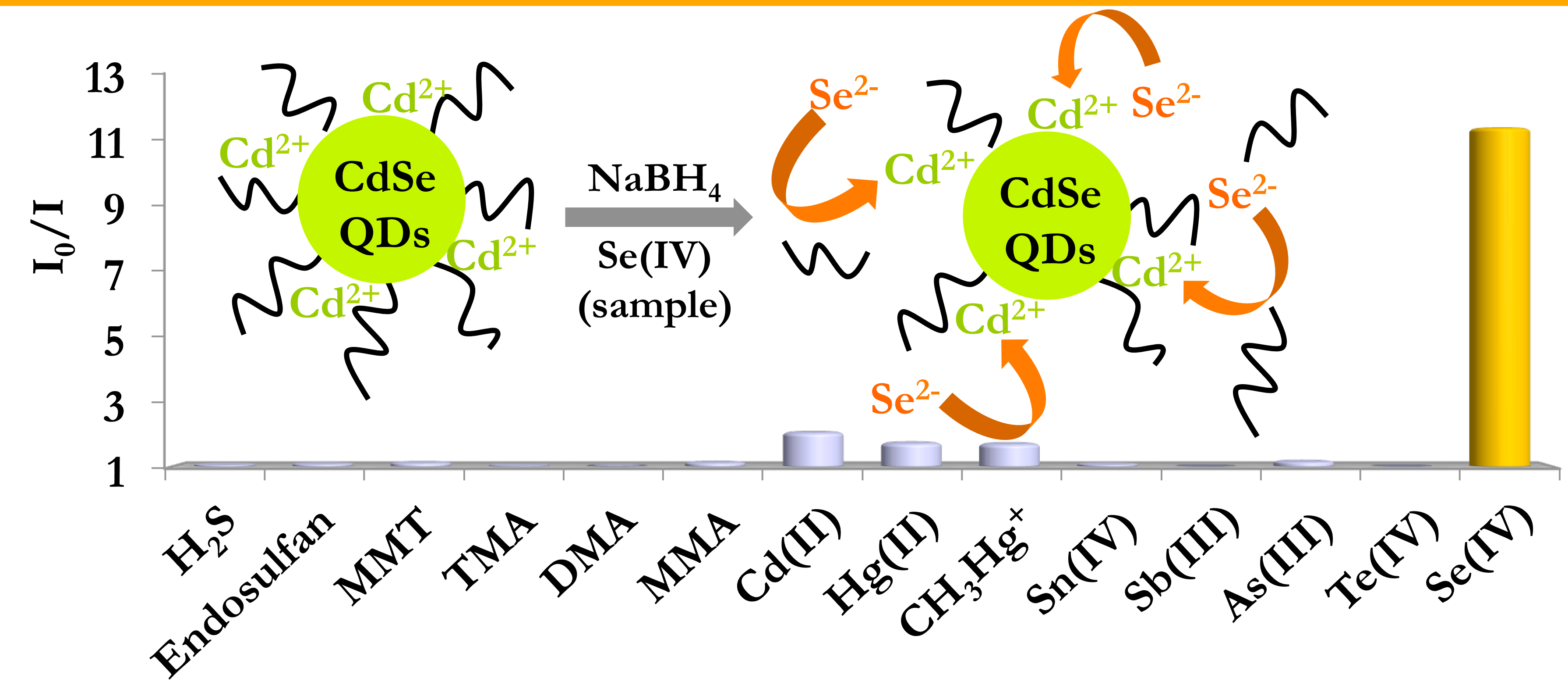
Aqueous drop containing Au NCs stabilized with sodium dodecyl sulfate for mercury detection



Analytical Performance for Hg(II)

Linearity	0.1 – 0.5 μM
Detection limit	0.04 μM
Quantification limit	0.13 μM
Repeatability (RSD)	5.8 % (n=7)
Reproducibility (RSD)	7.3 % (n=3)

CdSe QDs functionalized with hexadecylamine as luminescent probe for the selective and sensitive detection of selenium



Luminescence quenching occurs as a result of the binding between exogenous selenide trapped into the organic drop and Cd^{2+} contained in the QDs structure, which may cause the loss of stabilizing agent and, in turn, the luminescence quenching.

Analytical Performance for Se(IV)

Linearity	0.06 – 0.8 μM
Detection limit	1 nM
Quantification limit	5.1 nM
Repeatability (RSD)	4.6 % (n=7)
Reproducibility (RSD)	7.8 % (n=3)

GENERAL CONCLUSIONS

As has been demonstrated, several liquid-phase microextraction methodologies can be applied to develop fluorescent assays allowing:

I. The use of QDs dispersed in organic media in order to maintain their optical properties.

II. Miniaturization of the system.

III. Separation of the target analyte from other contaminants which causes an important improvement of the selectivity.

IV. Preconcentration of the target analyte in a microdrop in order to increase the sensitivity.

V. Reduction of sample and reagent volumes, hence decreasing of waste production, specially from QDs that usually incorporate toxic elements.

VI. To perform field analysis due to the portability of the detection system.

VII. To achieve high sample throughput.

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