Nanogold on porous glass for use as passive sampler of gaseous mercury

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Abstract
Gaseous elemental mercury (GEM) can lead to serious health problems. Its emission on the environment can originate from natural and anthropogenic sources at global scale. Thus, it is very important the development of practical samplers to monitor GEM. In this context, the aim of this work was the production of a passive sampler. For this purpose, gold nanoparticles (AuNP) were synthesized and deposited on SH-modified glass slides, and the qualities of this material for GEM monitoring were studied.

Key words: Gaseous elemental mercury, gold nanoparticles films, passive sampler

Introduction
Mercury is considered a global threat due to its high toxic potential. Although this element occurs naturally in the atmosphere, many anthropogenic emission sources contribute to increase the mercury levels in the environment.1,2 Environmental mercury contamination has concerned many countries, therefore, there is an increase in the development of new technologies for Hg monitoring.3,4 In this context, the aim of this work was the development of a gaseous elemental mercury (GEM) passive sampler, highly sensitive, portable, and cheap. For this purpose, gold nanoparticles (AuNP) were synthesized and deposited on SH-modified glass slides, and the qualities of this material for GEM monitoring were studied.

Results and Discussion
UV-vis absorption spectrum of the AuNP colloid shows the gold surface plasmon resonance band with maximum absorbance at 526 nm, indicating the formation of spherical gold nanoparticles. The same band was observed in spectrum of AuNP film, but with lower intensity and there was a wide band around 700 nm, which can be associated with the formation of nanoparticles aggregates, as verified by SEM images.

Transmission electron microscopy analysis showed that the co-synthesized AuNP exhibit spherical-like shape morphology with an average size distribution of 23.3 nm. Quantification of AuNP was performed by the determination of total gold in colloid and its two fractions - nanoparticles and supernatant – by using an inductively coupled plasma mass spectrometry (ICP-MS).

Table 1. Total gold concentration in the colloid and its fractions.

<table>
<thead>
<tr>
<th>Fraction</th>
<th>Concentration (µg L⁻¹)</th>
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<tbody>
<tr>
<td>Colloid</td>
<td>98 ± 4</td>
</tr>
<tr>
<td>AuNP</td>
<td>80 ± 2</td>
</tr>
<tr>
<td>Sobrenatant</td>
<td>17 ± 1</td>
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</table>

In order to evaluate the performance of the AuNP films for Hg⁰ sampling, some slides were exposed to the laboratory atmosphere for different periods (1 to 28 days), and the others were stored (unexposed), during the same time. Analyses of slides using Direct Mercury Analyser (DMA-80) allowed to quantify the mercury retained on each slide.

Figure 1. Retention of Hg⁰ by exposed AuNP samplers (N = 3) as a time function.

According to Figure 1, there was a linear increase in the retention of Hg⁰ in function of the exposure time. The maximum Hg amount retained was 50 ng per g of material, with an average retention of 2.2 ng g⁻¹ day⁻¹. The high linear correlation (R² = 0.99) between mercury retention and exposure time, beyond the high sensitivity, qualify the system as a passive monitor with potential for future field applications.

Conclusions
AuNP synthesis had a good yield, above 80% and, uniform distribution of them on the glass slides contributed to their effective performance when they were used as passive samplers for GEM monitoring in laboratory atmosphere.

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