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Polyaniline/Gold Nanoparticles: Assembly and Biological Applications

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Abstract – Colloidal gold nanoparticles (AuNPs) conjugated with polyaniline (PANI) can form a stable nanostructure (AuNPs-PANI), which makes it feasible to use these in bioassays. This study focuses on the preparation and characterization of AuNPs-PANI, using a simple and rapid method of preparation and use of this nanocomposite in the detection of oligonucleotide hybridization. The assembly sensor and immobilization of the primer and hybridization with the complementary sequence onto the surface of AuNPs-PANI were characterized by monitored spectrometric, electrochemical and optic measures. Mutually, the methods effectively identified the complementary from noncomplementary oligonucleotides, even at the single-base mismatch level.

Monodisperse metallic nanoparticles provide myriad uses, ranging from the traditional, such as catalysts and coloring agents, to more novel ones, such as hypothermic cancer therapy, fluorescent tags [1] and in the development of DNA sensors that identify critical harms to DNA [2].

To get ready the AuNPs-PANI nanocomposite, firstly, a colloidal gold suspension is prepared by reduction of the chloroauric acid ($HAuCl_{14}$) with sodium citrate, Frens method [3] modified. Initially, 3.6 mL of 1% sodium citrate was added to 62.5 mL of boiling distilled water, obtained from Milli-Q plus, and allowed to reflux for 3 min. This was followed by the addition of 0.63 mL of 1% $HAuCl_{14}$ and the suspension was refluxed for an additional period of 8 min. The suspension was allowed to boil, covered, for plus 3 min. Finally, gold sols were cooled, filter-sterilized (0.22 µm) and stored at 3 ℃ before their use. In the next step, coating AuNPs with polyaniline, 23 µL of aniline distilled, 1 mL of ammonium peroxydisulfate ($(NH4)_2S_2O_8$) and 0.5 mg of Synperonic PE/F68 were added to 10 mL of gold suspension, then stirred for 24h.

The DNA biosensor was manufactured based on the immobilization of two complementary oligonucleotides onto the surface of AuNPs-PANI nanocomposites. Initially, the primer COOH-5'-terminated G_{12}, was covalently immobilized to detect its fully complementary (C_{12}) and noncomplementary (A_5G_7) sequences in label-free conditions. Scan electron microscope (SEM) measurements (Figure 1a) show that the obtained PANI-capped-gold nanoparticles (AuNPs-PANI) are homogeneous with slight nanoparticles aggregation. The average particle size was around 18.0 and 165.0 nm before and after coating, respectively (Figure 1b). The nanocomposite seemed to be indefinitely stable at the room temperature even with the surfactant removal, the main particle radius happens to be 452 nm (AuNPs-PANI'), suggesting a very fast and strong flocculation. The UV-vis spectrum of a gold nanoparticle sample is a very sensitive reporter of the particle aggregation state [4]. UV-vis spectra of AuNPs exhibit a maximum attributable to a plasmon resonance (Figure 1c). This maximum in water is 520 nm, which is consistent with the reported value for particles with similar size [4]. Analyses via FTIR indicated that there is an interaction between the polymer amino groups and the carboxylic groups modified oligonucleotides, according to the bands assignments from 1725 to 1620 cm^{-1} that can be correlated to the tertiary amide C=O groups of the bond between AuNPs-PANI and the primer.

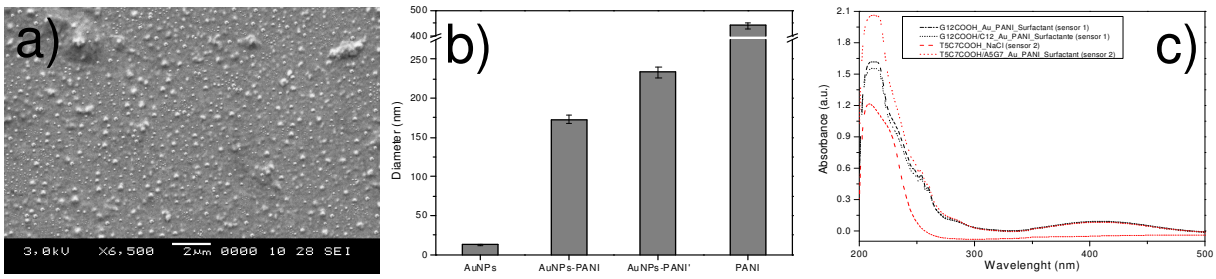

Figure 1: a) SEM image, **b)** Size and **b)** Uv-vis.

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