**MicroRNA detection through upconversion emission enhancement between NaYF₄:Yb,Er nanoparticles and carbon dots**

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MicroRNAs are non-coding sequences of 20-25 nucleotides and they are important in the transcriptional mechanisms of gene expression. Many viruses such as HIV, Ebola, Hepatitis C, Dengue, etc. can encode and express specific viral miRNAs that help the viral replication facilitating the host infection [1]. Those miRNAs can be found in sera samples at relatively high concentration opening the possibility to be used as early diagnosis biomarkers [2]. We have developed a novel sensor for the detection of specific miRNA sequences that was based on graphene quantum dots (GQDs) and upconversion nanoparticles (UCNPs) functionalized with SiO₂ and single stranded DNA (ssDNA). The proposed sensor exploits the interaction between the sp² carbon atoms of GQDs and the ssDNA anchored on the UCNPs. This interaction brings the GQD to the surface of the UCNPs-SiO₂-ssDNA system enhancing the fluorescence emission of the upconversion nanoparticles. On the other hand, the hybridization of the ssDNA chains on the surface of the nanoparticles with their complementary miRNA sequence blocks the capacity of the UCNPs to interact with the GQD reducing the fluorescent enhancement that is dependent on the concentration of the miRNA sequence. Using a relative emission/upconversion measurements compared to a reference, the miRNA sensor showed a detection limit of 10 fM.

![Figure 1. Schematic representation of the proposed sensor platform based on UCNPs-SiO₂-ssDNA and GQDs.](image)

**Figure 1.** Schematic representation of the proposed sensor platform based on UCNPs-SiO₂-ssDNA and GQDs.

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