# On-board smartphone micromotor-based fluorescence assays

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Experimental

Micromotor synthesis. All reagents used were obtained from Sigma-Aldrich (Spain) and used without further purification. For the synthesis of ZnS@Cd$_x$Se$_{1-x}$/graphene oxide (GO)/Fe$_2$O$_3$ Janus micromotors, polystyrene microparticles (PS) with a 20 μm diameter were used as base particles (cat. 87896). In brief, a monolayer of PS particles was covered with a ~50 nm gold layer, followed by modification with GO by incubation of 0.9 mL of ultrapure water containing the modified particles and 0.1 mL of sulfhydryl-modified graphene oxide (HS-GO) (cat. 763705) for 2 h to promote attachment to gold by thiol bond. Next, 20 μL of Fe$_2$O$_3$ NPs solution (1 mg/mL, cat. 544884) was added and the solution was mixed for 1 h to generating the magnetic engine, followed by cleaning with a filter to remove unbounded magnetic particles, as well as 5 μL of ZnS@Cd$_x$Se$_{1-x}$ QDs (cat. 753904) was added furtherly to modify the micromotors. The micromotors remains stable for 1 month without any changes in its properties. Tubular GDY/Pt micromotors were synthetized by template electrodeposition. A polycarbonate membrane compromising 5 μm diameter conical pores (Cat. WHA110413) was covered with a thin gold layer and assembled in a custom-made electrochemical cell. A Pt wire and an Ag/AgCl respectively. The outer micromotor layer was electrodeposited from a solution containing 0.1 mg mL^{-1} of GDY and 0.5 mol L^{-1} of Na$_2$SO$_4$ by cyclic voltammetry (n=10, 0.3 V to -1.5 V, 50 mV s^{-1}). The inner platinum layer was electrodeposited by applying a -0.4 V potential for 750 s and a solution containing 4 mmol L^{-1} of chloroplatinic acid hydrate (cat. 398322) in 0.5 mol L^{-1} boric acid (cat. B0394). The micromotors were released from the membrane (3M) electrode were used as counter and reference electrode, by polishing the Au layer and immersion in methylene chloride, isopropanol and dispersion in water. The micromotors were next modified with a Rhodamine-B labelled affinity peptide (B-VQCRLGPPWCAK, Neo-Biotech, Nanterre, France) specific for the detection of CTB. To this end 100 μL of the affinity peptide solution (100 μg mL^{-1}) were added to an Eppendorf tube containing 1 batch of dry motors (500,000 motors), 150 mL of 3% sodium dodecyl sulfate (cat. 71727) and 200 μL of ACN:H$_2$O$_2$ 1:3 for 1 h.

Supporting Figures
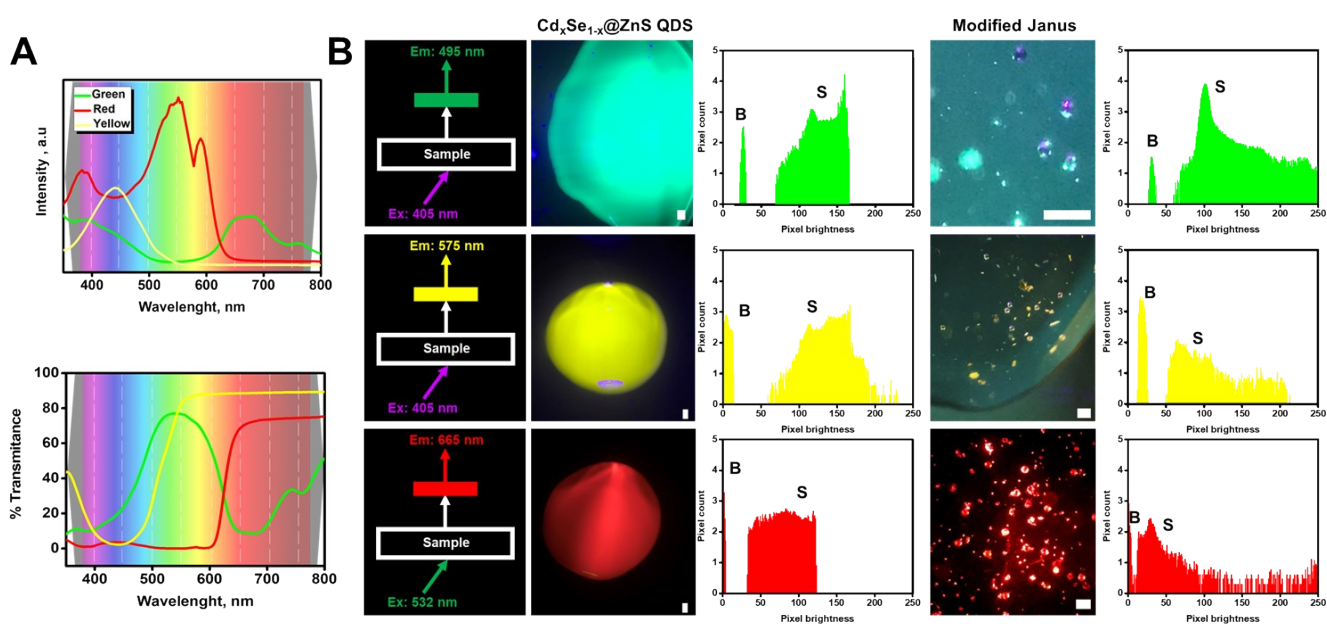
Figure S1. Evaluation of the performance of the smartphone-based fluorescence platform. A) Absorbance and corresponding transmittance profiles of the green, yellow or red emission filters. B) Fluorescence images of ZnS@Cd$_x$Se$_{1-x}$ QDs solutions or modified Janus micromotors and corresponding histograms (in log scale) where B indicate background signal and S the fluorescence signal of the solution or the micromotor, respectively. For the specific excitation and emission conditions, see images at the left of each figure. Scale bars, 50 μm

Table S1. Optical fluorescence smartphones for diseases diagnosis

Biomarker	Disease	Sample	Sample processing	Analytical performance	Ref
Endpoint detection					
Escherichia coli	Track urinary infections	Urine	Propylene microchips with integrated fluorescent sandwich immunoassay	LOD: 240 CFU mL^{-1} LR: 10^0–10^7 CFU mL^{-1} Time: 30 min	[1]
Staphylococcus aureus	Antibiotic resistance	Blood	Lateral strip based fluorescent sandwich immunoassay microchip	LOD: 4.7×10^3 DNA copies Time: 30 min	[2]
Viruses	HIV Hepatitis B	Whole blood	Microchip with DNA modified quantum dots barcodes	LR: 10^3-10^9 virus mL^{-1} Time: 50 min	[3]
Viruses	Infections	Nasal swabs	Microfluidic chip loop-mediated isothermal amplification	LOD: 5.5×10^4 virus mL^{-1} Time: 30 min	[4]
Hepatitis B virus	Hepatitis B	-	Microfluidic chip integrating immiscible phase filtration assisted by surface tension and loop isothermal amplification	LR: 10^1-10^9 virus/mL Time: 60 min	[5]
Zika virus	Infections	Serum	Paper strip fluorescent lateral flow immunoassay	LOD: 0.15 ng mL^{-1} LR: 0.15-1000 ng mL^{-1} Time: 20 min	[6]
Prostate specific antigen	Cancer	Whole blood	Microchip based sandwich enzyme linked immunoassay (test strip sample)	LOD: 0.04 ng mL^{-1} LR: 0.9-60 ng mL^{-1} Precision:11% Time: 15 min	[7]
Glucose Lactose Urea	Diabetes	Serum	MOF@enzyme modified paper sensor	LOD: mM range	[8]
Glutathione	Alzheimer, cancer prognosis	Human serum	Strip paper modified with carbon dots, gold nanoparticles and copper	LOD: 1 µM (307 ng mL^{-1}) LR: 1-10 µM (307-3070 ng mL^{-1}) Time: 4 min	[9]
Dipicolinic acid (DPA)	Anthrax infection	Serum Urine	Paper embedded with Terbium/DPA@SiO$_2$-Europium/guanosine monophosphate	LOD: 1 µM (167.12 ng mL^{-1}) LR: 3-200 µM (Time: 10 min	[10]
Brain natriuretic peptide (BNP) Suppression oftumorigenicity 2 (ST2)	Heart failure	Serum	Lateral flow immunoassay paper with upconversion nanoparticles (NaYF$_4$:Yb,Tm and NaYF$_4$:Yb,Er)	LOD: 29.92 ng mL^{-1} (ST2); 17.46 pg mL^{-1} (BNP) Time: 20 min	[11]
Estrogen	Pre-eclampsia	Skin	Antibody-modified nanoneedles	LOD: 0.13 µM LR: 0.5-1000 ng mL^{-1} Time: 1 min	[12]
Real-time detection					
Hemoglobin	Leukemia Anemia Heart diseases	Whole blood	SiO$_2$@ quantum dots integrated in a microchip with acoustofluidic enrichment	LOD: 0.035 µg mL^{-1} LR: 0-100 µg mL^{-1} Time: 2 min	[13]
Hg^{2+}	Intoxication	Wastewater	Paper modified with thymine (T)-mismatched DNA probes	LOD: 1 nM (0.0002 µg mL^{-1}) LR: 0.001-10^4 nM	[14]
Hg^{2+} Cholera Toxin B	Intoxication	Serum	-	LOD: 0.08 µg mL^{-1} (Hg^{2+}), 1.6 ng mL^{-1} (Cholera Toxin B) Time: 2-5 min	This work

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