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SUPPORTING INFORMATION

Glucose oxidase-encapsulated liposomes for amplified autofluorescence-free immunoassay of prostate-specific antigen with photoluminescence of $CePO_4$:Tb nanocrystals

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TABLE OF CONTENTS

Reagents and chemicals S3

Apparatus S3

Figure S1. Particle size distribution of liposomes.. S4

Figure S2. PL intensity of CPOT at different pH. S4

Table S1. Comparison of the methods for PSA detection developed by other researchers. S5

References S6

Reagents and chemicals

PSA ELISA kit containing PSA standards, glucose oxidase (GOD), bovine serum albumin (BSA), monoclonal anti-human PSA capture antibody (mAb_1), monoclonal anti-human PSA detection antibody (mAb_2) and all buffer solutions were purchased from Sangon-Biotech (Shanghai, China); High-binding polystyrene 96-well microplates were obtained from Greiner Bio-One (Frickenhausen, Germany); 1,2-dipalmitoyl-sn-glycero-3-phosphocholine (DPPC), 1,2-dipalmitoyl-sn-glycero-3-phosphoethanolamine (DPPE), glutaraldehyde (AR, 50 wt %) , Triton X-100, citric acid monohydrate, glucose, $Ce(NO_3)_3 \cdot 6H_2O$ (99.95%), $Tb(NO_3)_3 \cdot 6H_2O$ (99.9%) were purchased from Aladdin (Shanghai); Chloroform, cholesterol and concentrated phosphoric acid were procured from Sinopharm Chem. Re. Co., Ltd. All other reagents used were A.R. grade. Ultrapure water with a resistivity of 18 MΩ*cm (purified by a Millipore water purification system) was used in all steps.

Apparatus

X-ray diffraction (XRD) patterns were collected using an X-ray diffractometer (RigakuUltima III) with high-intensity Cu Kα1 irradiation (λ = 1.5406 nm). X-ray photoelectron spectra (XPS) were recorded on a Kratos standard and monochromatic source (Al KR) operated at 15 kV and 10 mA. Transmission electron microscopy (TEM) was performed on a JEOL JEM-2100 microscope at an acceleration voltage of 200 kV, and Zetaszier Nano-ZS90 (Malvern) was also used. Photoluminescence spectra and luminescence decay curves were recorded on an F-4600 fluorescence spectrophotometer (Hitachi, Japan).

Preparation of mAb1-coated microplate

Briefly, 50 µL of mAb1 (10 µg/mL) was injected into the wells of a high binding polystyrene microplate as a PSA capture unit and incubated overnight at 4 °C. PBS buffer (0.1 M, pH 7.4) containing 0.05% Tween 20 was used as a washing solution to wash away unbound mAb_1 antibody. Subsequently, non-specific binding sites were blocked by incubation with blocking buffer (10 mM PBS containing 1.0 wt% BSA, pH 7.4) for 1 h at 4 °C and the remaining BSA was removed by washing with washing solution.

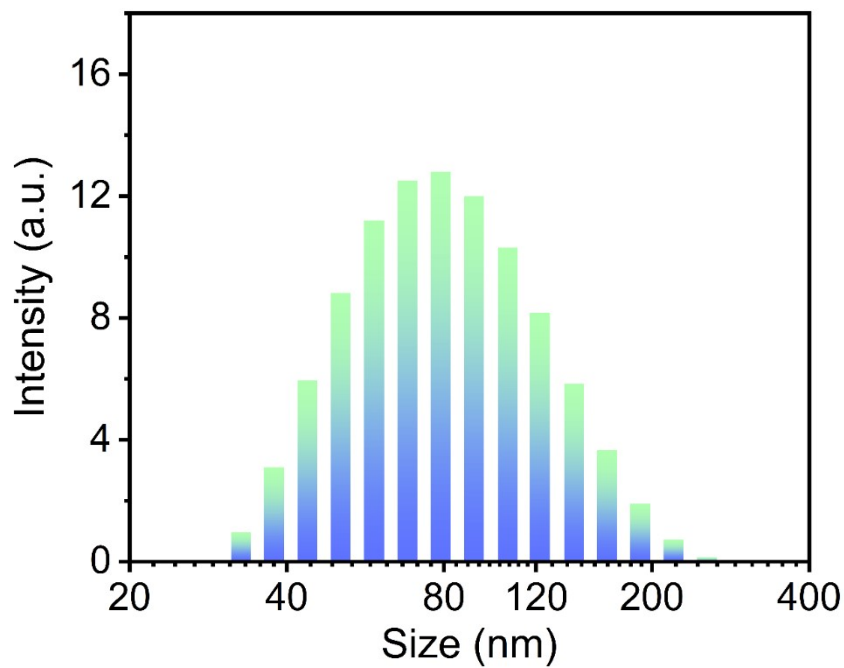

Figure S1. Particle size distribution of liposomes.

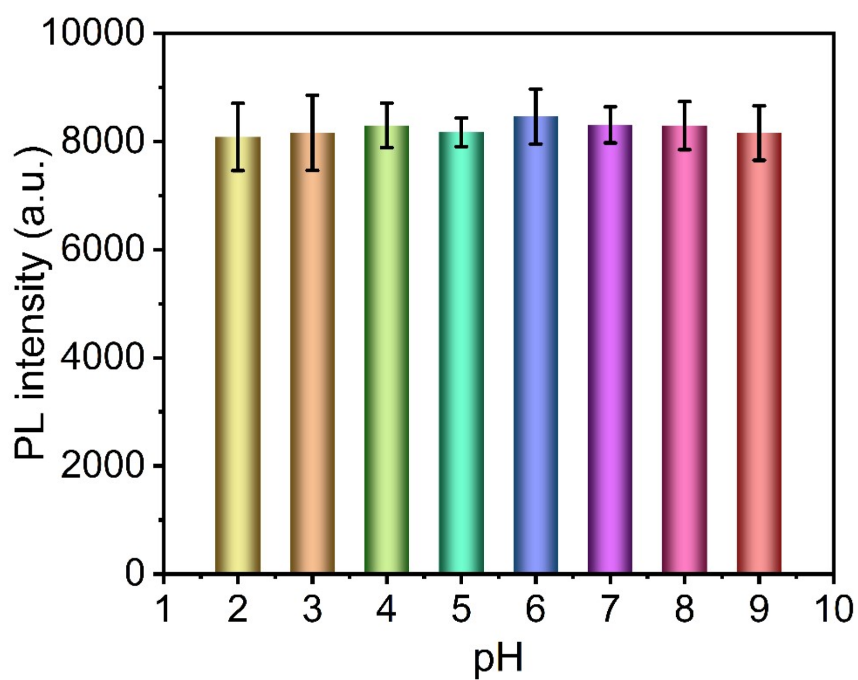

Figure S2. PL intensity of CPOT at different pH values.

Table S1. Comparison of the methods for PSA detection developed by other researchers.

Method	Materials	Linear range (ng/mL)	LOD (pg mL^{-1})	Refs
Persistent luminescence assay	Zn_2GeO_4: Mn^{2+}, Pr^{3+} nanorods	0.005-25	3.25	This work
Persistent luminescence aptasensor	ZnGeO:Mo NRs and Au@Ag@SiO2 NPs	0-10	9.2	[1]
Immunochromatography test strip	semiconducting polymer dots	2-10	320	[2]
Fluorescence aptasensor	carbon dots (CDs) and graphene oxide (GO)	1-100	220	[3]
SERS immunosensor	$Cu_{2-x}S_ySe_{1-y}$ NPs and Ag NPs	3-120	2490	[4]
Photoelectrochemical immunosensor	CuS QDs and CdS@g-C_3N_4 heterojunction	0.01-50	4	[5]
Electrochemical aptasensors	poly A aptamer and AuNPs	0.1-100	20	[6]

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