Supporting Information

Ultrasensitive electrochemical immunosensor for the detection of C-reactive protein antigen

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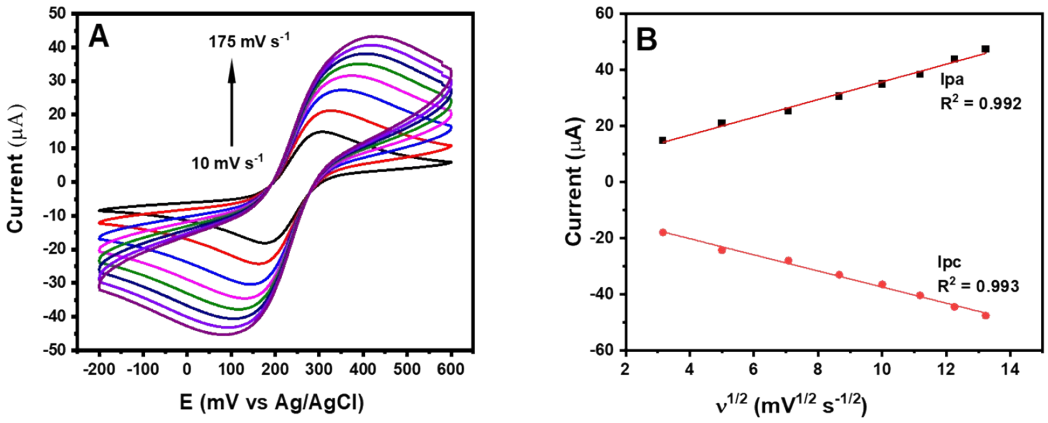

Figure S1. (A) Cyclic voltammograms of the BSA/CRP-AB/OLC-PAN/GCE electrode recorded in a 0.1M PBS + 0.1 M KCl solution (pH 7.4) containing 5.0 mM $[Fe(CN)_6]^{4-}$ solution at varied scan rates. (B) Linear plots of the peak currents (Ip/μA) against the square root of the scan rate [$\upsilon^{1/2}$ / ($mV^{1/2}$ $s^{-1/2}$)].

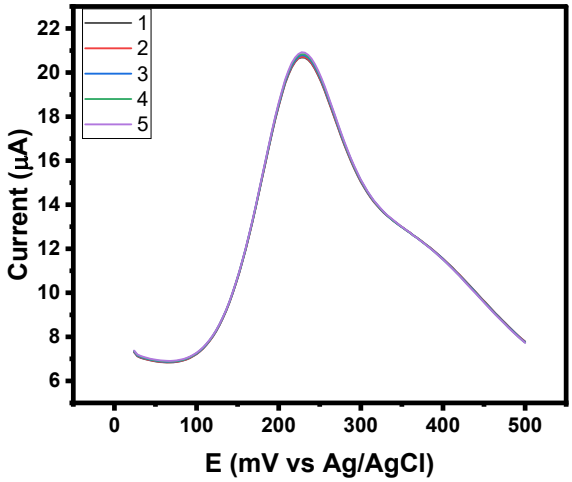

Figure S2. To test the reproducibility, SWVs of five modified GCEs (1 to 5) were recorded in a 0.1M PBS solution (pH 7.4) containing 0.1 M KCl, 5 mM $[Fe(CN)_6]^{4-}$ and 0.94 ng mL^{-1} CRP at room temperature with an amplitude of 25 mV and frequency of 15 Hz.

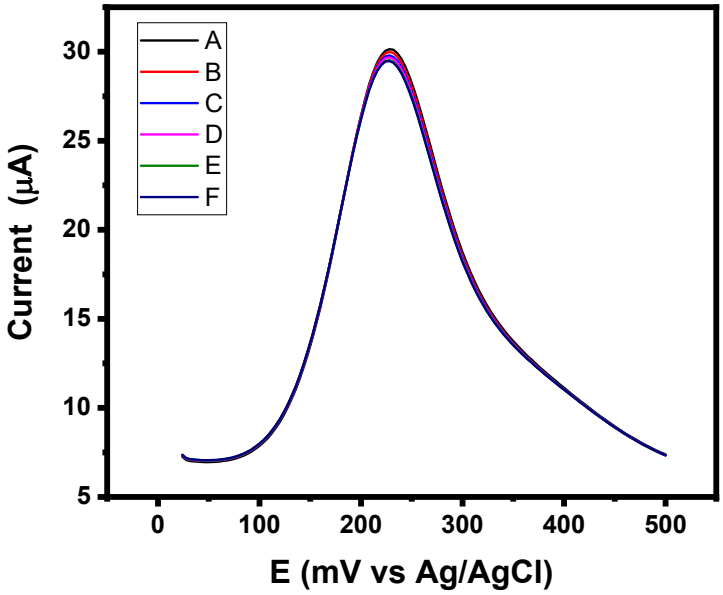

Figure S3. Stability tests based on six SWV consecutive measurements of the modified electrode tested CRP (29 pg mL^{-1}) for six consecutive times (A to F), showing about 95% current stability. Under conditions with an amplitude of 25 mV, frequency of 15 Hz, and potential ranges from 20 to 500 mV, the measurements were carried out in a 0.1M PBS solution (pH 7.4) containing 0.1 M KCl and 5 mM $[Fe(CN)_6]^{4-}$ at room temperature.

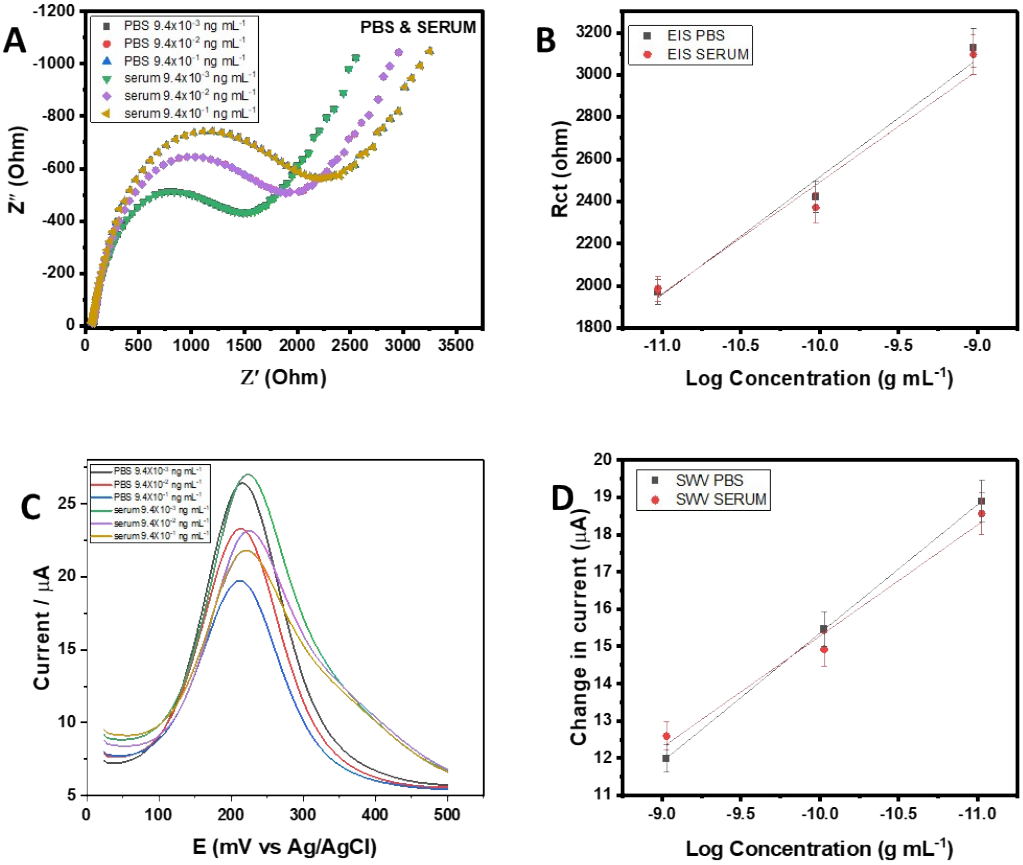

Figure S4. The recovery tests were based on three different concentrations of the CRP antigen (9.4×10^{-3}, 9.4×10^{-2}, and 9.4×10^{-1} ng mL^{-1}) with a constant concentration of 70 µg mL^{-1} CRP antibodies in the PBS and spiked in the human serum. (A) Nyquist plots of the three concentration samples in both PBS and Serum measured at EIS Bias 235 mV, amplitude 5 mV, frequency ranges from 0.1 to 100 k Hz. (B) The associated plots obtained from (A). (C) SWVs of the three concentration samples in both PBS and Serum recorded with amplitude 25 mV frequency 15 Hz, potential ranges from 20 to 500 mV. (D) The corresponding plots obtained from (C). All the measurements were performed in a 0.1M PBS solution (pH 7.4) containing 0.10 mol L^{-1} KCl and 5 mM $[Fe(CN)_6]^{4-}$ (redox probe) under ambient conditions.

Table S1. The EIS data fitting parameters values were obtained from the modified electrode of bare GCE to BSA-AG.

Electrodes	**Rs (Ω)**	**CPE 1-T (μF)**	**CPE 1-P**	**Rct (Ω)**	**Zw1-R ($\Omega\ s^{-0.5}$)**	**Zw1-T ($s^{0.5}$)**	**Zw1-P**
Bare GCE	56	1.7	0.9	$7.4x10^2$	$9.6x10^4$	$1.2x10^4$	0.5
Error %	0.4	2.9	0.3	0.7	8.4	1.6	0.8
CRP-AB/OLC-PAN/GCE	55	0.2	0.8	$1.1x10^3$	$1.1x10^5$	$1.8x10^4$	0.5
Error %	0.3	2.1	0.4	1.6	9.8	2.7	1.8
BSA/CRP-AB/OLC-PAN/GCE	57	0.1	0.8	$1.7x10^3$	$1.1x10^5$	$2.2x10^4$	0.5
Error %	0.3	1.8	0.3	1.4	8.9	1.8	2.6
CRP /BSA/CRP-AB/OLC-PAN/GCE	55	0.1	0.8	$2.3x10^3$	$3.1x10^5$	$2.1x10^5$	0.01
Error %	0.3	1.7	0.3	1.5	5.9	9.1	3.6

Table S2. Application of immunosensor in the human serum sample using the EIS technique.

Sample	**Spiked amount ($ng\ mL^{-1}$)**	**Average recovered ($ng\ mL^{-1}$)**	**RSD (%, n=5)**	**Recovery (%)**
1	$9.4\ x10^{-3}$	$9.7\ x10^{-3}$	0.7	103
2	$9.4\ x10^{-2}$	$9.6\ x10^{-2}$	1.0	102
3	$9.4\ x10^{-1}$	$9.8\ x10^{-1}$	1.2	104