Electronic Supplementary Material (ESI) for Analyst.

Supporting Material

A new electrochemical substrate for rapid and sensitive *in-vivo* monitoring of *β*-galactosidase gene expressions

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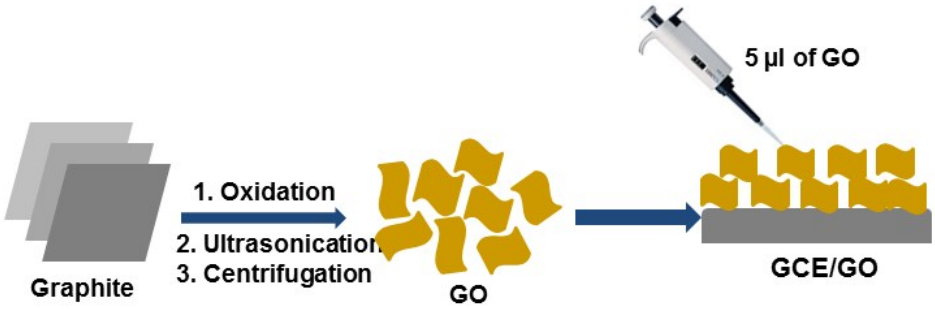

Fig. S1. Preparation of graphene oxide from graphite

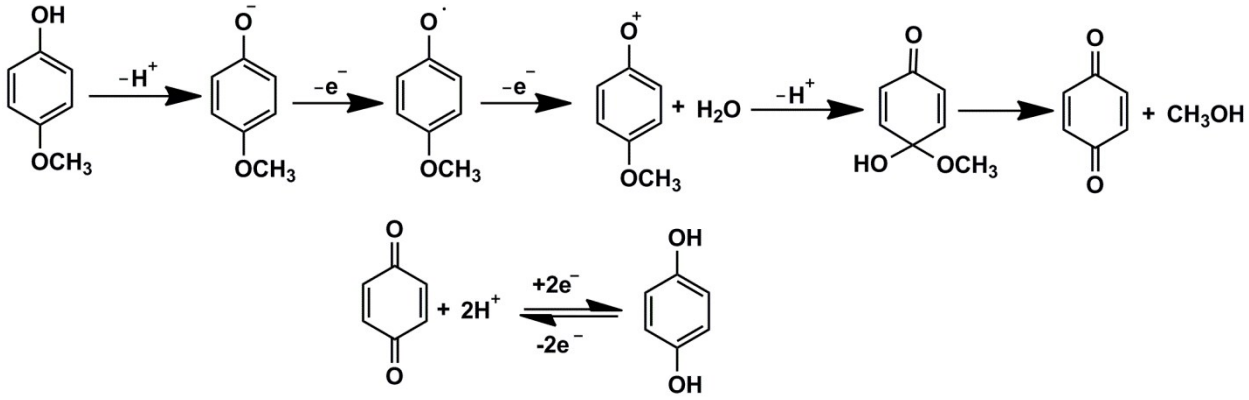

Fig. S2 Mechanism for the electrochemical oxidation of 4-MP

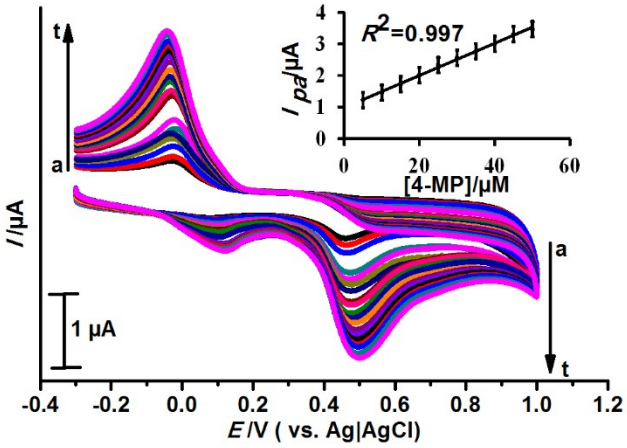

Fig. S3 *E. coli*: CVs obtained at GO/GCE in tris buffer (pH 7.3) containing different concentrations of pristine 4-MP. Inset: I_{pa} versus [4-MP]; $I_{pa}/\mu A = 0.0171$ [4-MP] (µM) + 0.602.

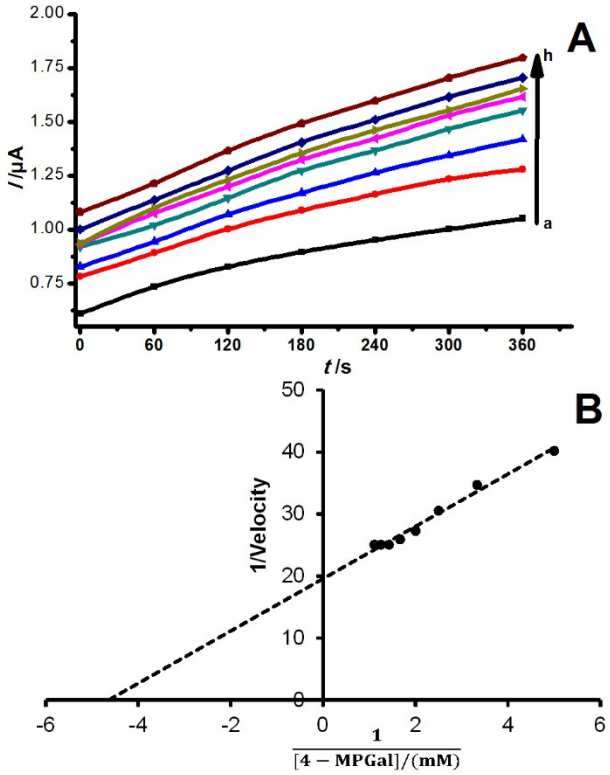

Fig. S4 *E. coli*: (A) Kinetic linear transformation curves at increasing concentrations of 4-MPGal (a = 0.1 mM, b = 0.2 mM, c = 0.3 mM, d = 0.4 mM, e = 0.5 mM, f = 0.6 mM, g = 0.7 mM, h = 0.8 mM and i = 0.9 mM) containing 3.8 µg of *β*-Gal. (B) Lineweaver-Burk plot of hydrolyzed 4–MP against different concentration of 4-MPGal (0.2–0.9 mM).

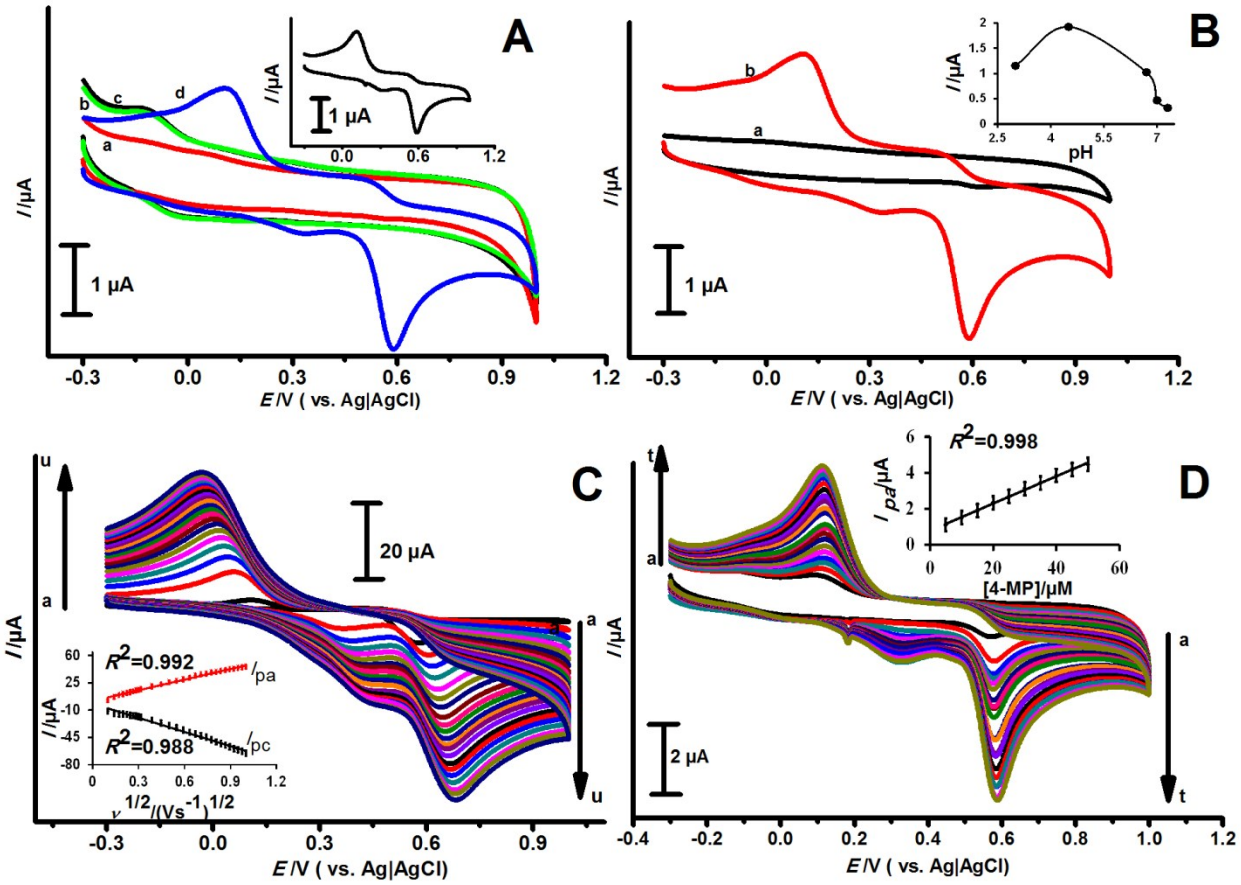

Fig. S5 *A. oryzae*: (A) CVs obtained at GO/GCE in 50 mM acetate buffer (pH 4.5) (a), containing 1 mM 4-MPGal (b), 10 µg *β*-Gal (c) and mixture of 10 µg *β*-Gal and 1 mM (d). Inset: CV obtained at GO/GCE in 50 mM acetate buffer (pH 4.5) containing 0.1 mM of 4-MP. The scan rate was 0.1 Vs^{-1}. (B) CVs obtained at bare GCE and GO/GCE in 50 mM acetate buffer (pH 4.5) containing 1 mM 4-MPGal and 10 µg *β*-Gal at scan rates of 0.1 Vs^{-1}. Inset: pH optimization: [current] (µA)/pH. CVs obtained at GO/GCE in Tris buffer (different pH) containing 1 mM 4-MPGal and 0.63 µg of *β*-Gal. (C) CVs obtained at GO/GCE in 50 mM acetate buffer (pH 4.5) containing 1 mM 4-MPGal and 10 µg *β*-Gal at different scan rates from 0.01 Vs^{-1} to 1 Vs^{-1}. Plot of I_{pa} and I_{pc} versus $v^{1/2}$; $I_{pa}/\mu A = 45.60\ v^{1/2}/(Vs^{-1})^{1/2} + 1.712$; $I_{pa}/\mu A = -60.76\ v^{1/2}/(Vs^{-1})^{1/2} - 1.523$. (D) CVs obtained at GO/GCE in tris buffer (pH 7.3) containing different concentrations of 4-MP. Inset: I_{pa} versus [4-MP]

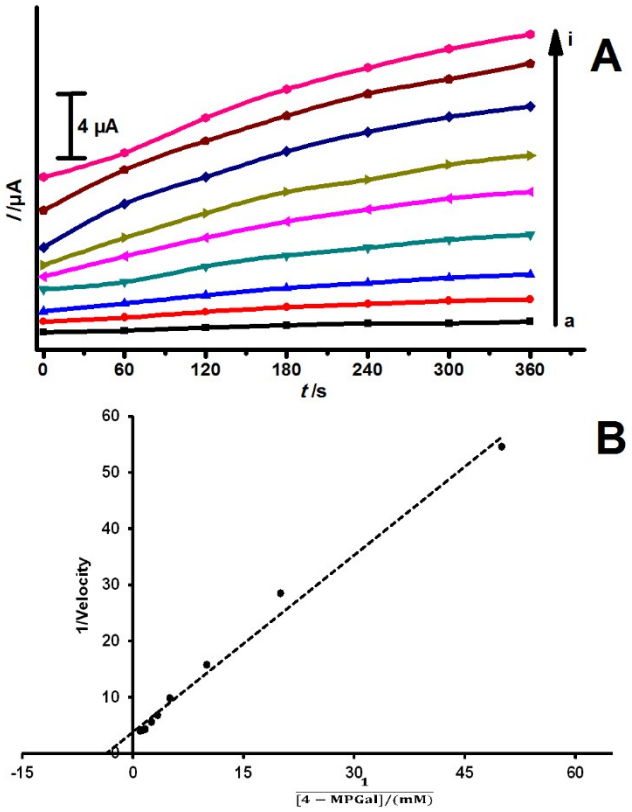

Fig. S6 *A. oryzae*: (a-i) Kinetic linear transformation curves for the increasing concentration of 4-MPGal (a= 0.02 mM, b= 0.05 mM, c= 0.1 mM, d= 0.2 mM, e= 0.3 mM, f= 0.4 mM, g= 0.6 mM, h= 0.8 mM, i= 1.0 mM) upon treated with 12.5 µg *β*-Gal (1U). (B) Michaelis–Menten plot of hydrolyzed 4-MP against different concentration of 4-MPG (0.02-1 mM).

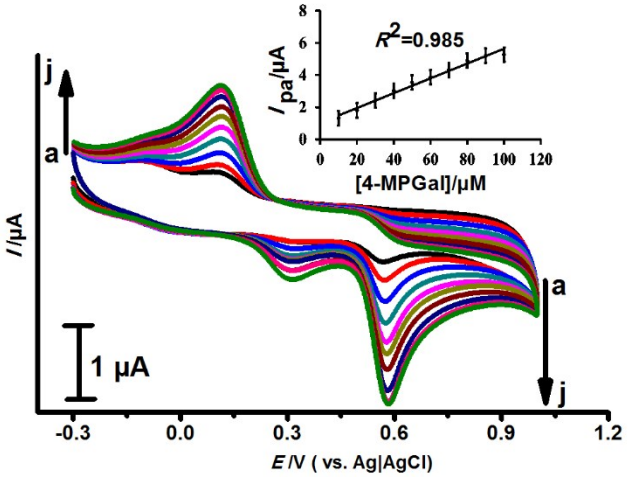

Fig. S7 *A-oryzae*: CVs obtained at GO/GCE in 50 mM acetate buffer (pH 4.5) containing 12.5 µg of *β*-Gal and different concentration of 4-MPGal (each addition of 10 µM) at scan rate from 0.1 Vs^{-1}. Inset: I_{pa} versus [4-MPGal]; $I_{pa}/\mu A = 0.0461$ [4-MPGal] (µM) + 1.024.

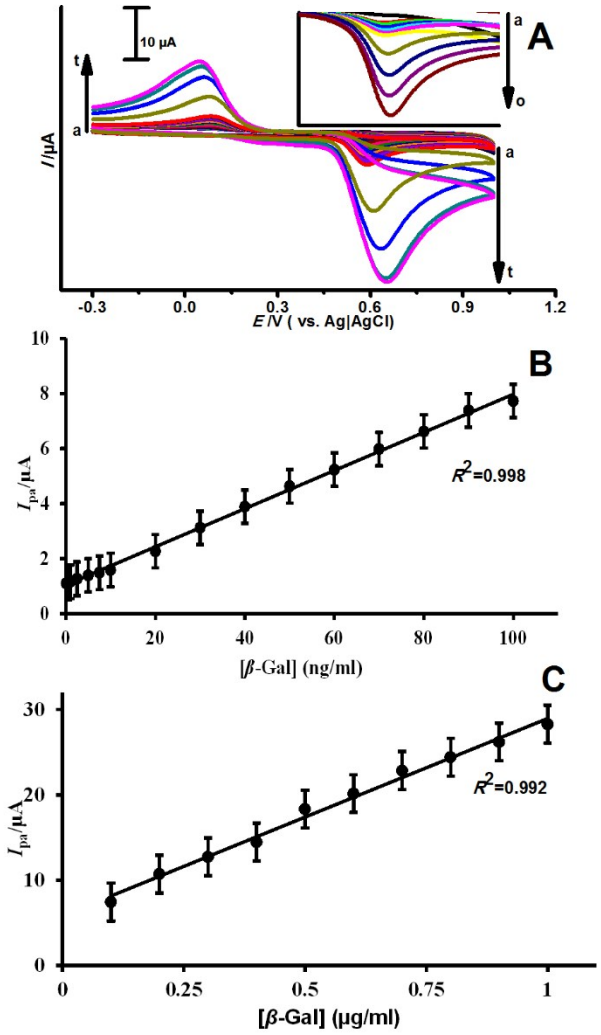

Fig. S8 *A. oryzae*: CVs obatined sat GO/GCE in 50 mM acetate buffer (pH 4.5) containing various concentration of *β*-Gal and 1 mM 4-MPGal (a= 0.1 ng, b= 0.5 ng, c= 1 ng, d= 2.5 ng, e= 5 ng, f= 7.5 ng, g= 10 ng, h= 20 ng, i= 30 ng, j= 40 ng, k= 50 ng, l= 60 ng, m= 70 ng, n= 80 ng, o= 90 ng, p= 200 ng, q=400 ng, r= 600 ng, s= 800 ng, t= 1000 ng). (B) I_{pa} vs. [*β*-Gal]; $I_{pa}/\mu A = 0.069$ [*β*-Gal]/ (µA/ng) + 1.046. (C) I_{pa} vs. [*β*-Gal]; $I_{pa}/\mu A = 23.14$ [*β*-Gal]/ (µA/µg) + 5.837.

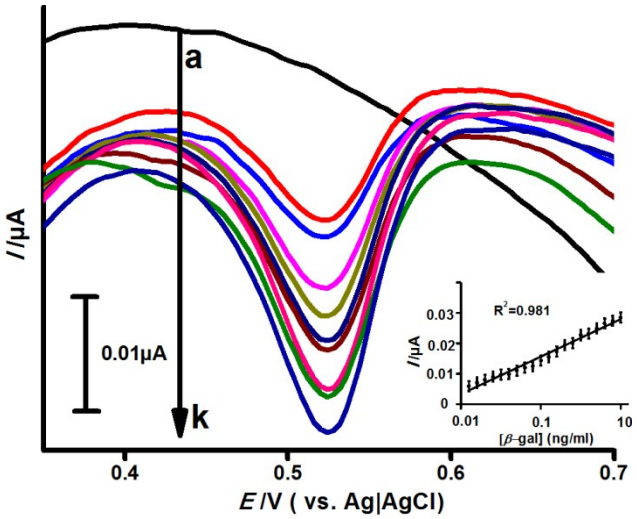

Fig. S9 *A. oryzae*: DPVs obtained at GO/GCE in 50 mM acetate buffer (pH 4.5) (a) containing 4-MPGal (1 mM) with increasing concentration of *β*-Gal (b= 10 pg, c= 20 pg, d= 30 pg, e= 40 pg, f= 50 pg, g= 60 pg, h= 70 pg, i= 80 pg, j= 90 pg, k=100 pg). Inset: Linear calibration plot: [*I*]/μA vs. [*β*-Gal]; *I*/μA = 12.3 [*β*-Gal]/ (nA/μg) + 0.034.

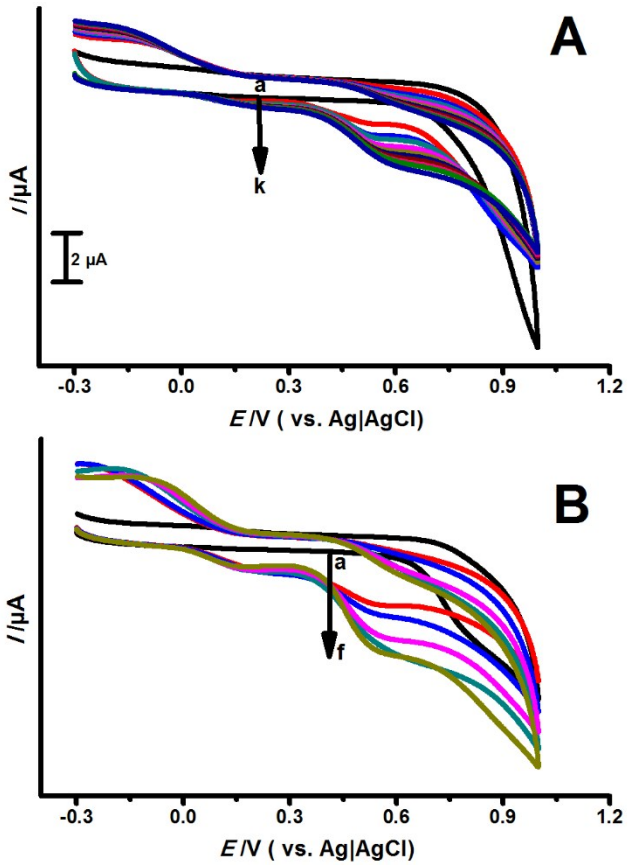

Fig. S10 (A) CVs obtained at GO/GCE in broth medium (a) with the presence of different concentrations of 4-MP (b-k; each additions of 100 µM). (B) CVs obtained at GO/GCE in broth medium (a) containing 5.3 µg *β*-Gal from *E. coli* and different concentration of 4-MPGal (each addition (1 mM (b), 2 mM (c), 3 mM (d), 4 mM (e) and 5 mM (f)).

In order to prove that our scheme works in the LB broth medium, we presents the cyclic voltammograms carried out for LB broth medium containing different concentrations of pristine 4-MP (**Fig. S10 (A)**) and different concentrations of 4-MPGal (**Fig. S10 (B)).** The linear dependence of the response currents with the concentration of pristine 4-MP and 4-MPGal is indicating the satisfactory performance of our scheme in broth medium.

Table S1 Data for the optimized parameters

Optimized Parameters	**Data**
pH	pH 7.3 for *E. coli* (Inset b, Fig. 1B)
	pH 4.5 for *A. oryzae* (Inset, Fig. S5 (B))
Concentration of GO	5 µl (inset a, Fig. 1B)
Scan rate	100 mV (Fig. 1C for *E. coli*; Fig. S5 (C) for *A. oryzae*)
CV parameters	Potential range = -0.3 V to +1.0 V and scan rate of 0.1 Vs^{-1}
DPV parameters	Amplitude= 0.05 V, sampling width= 0.0167 s, pulse period= 0.5 s.
K_m	0.21 mM for *E. coli* (Fig. S2)
	0.27 mM for *A. oryzae (*Fig. S7)