Supporting Information

An efficient way to reduce graphene oxide by water elimination using phosphoric acid

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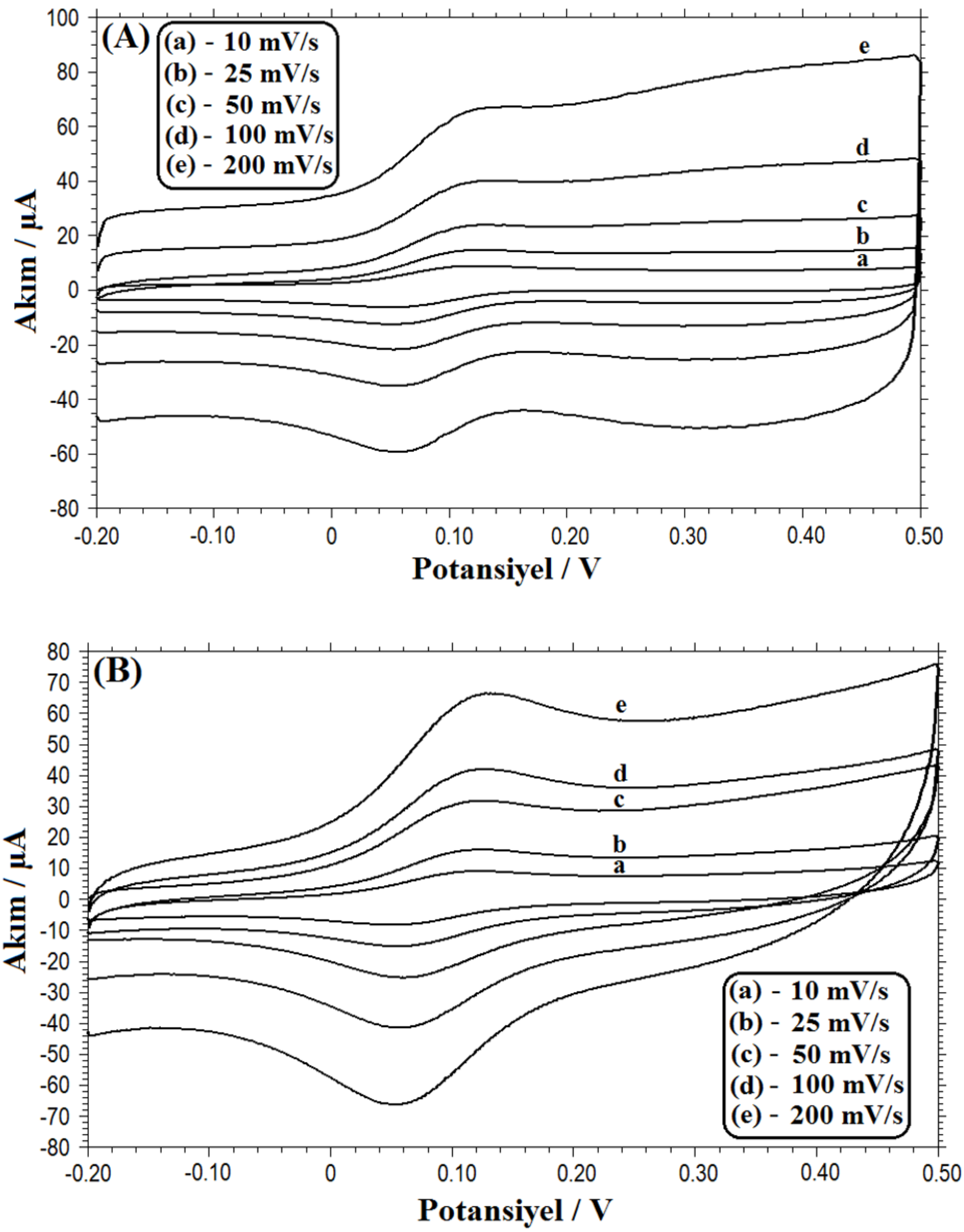
The heterogeneous electron transfer rates of $NaBH_4$-G, H_2SO_4-G and H_3PO_4-G were determined with Nicholson[1] method using the cyclic voltammograms of $Fe(CN)_6^{3-}$. The GC electrodes covered by $NaBH_4$-G, H_2SO_4-G and H_3PO_4-G gave heterogeneous electron rate constants (k^0) of 0.00313 ± 0.00043, 0.0122 ± 0.0096 and 0.0305 ± 0.00293 $cm.s^{-1}$ by the use of Equation 1 for 1.0 mM $Fe(CN)_6^{3-}$ solution in 1.0 M KNO_3. These results showed that the electron transfer kinetics of H_2SO_4–G and H_3PO_4–G were significantly faster than graphene prepared by the classical method and the other carbonaceous materials are shown in Table S1. The fact that the rate of electron transfer for graphene electrodes prepared by the acidic method was higher means that they have lower polarizability and therefore higher electrocatalytic activity. Accordingly the k^0 values are in good accordance with the specific capacitance values listed in Table 2. It is observed that $NaBH_4$-G electrode with high capacitance values have lower electron transfer rate values which verifies this fact.

$$k^0 = \Psi\left(\frac{D_0 \pi \nu F}{RT}\right)^{1/2} \tag{1}$$

Table S1. The heterogeneous electron rate constants (k^0) of various carbonaceous materials.

Carbonaceous Materials	**Heterogeneous Electron Rate Constants (k^0), $cm \cdot s^{-1}$**	**Reference**
Graphite (Surface defects free)	10^{-6}	[2]
Basal HOPG	2.26×10^{-5}	[3]
Edge HOPG	5×10^{-3}	[3]
Glassy carbon	3×10^{-3}	[3]
Single sheet graphene	1.2×10^{-3}	[4]
Few layer graphene	7×10^{-4}	[4]
Bulk graphene (Thermally reduced)	5×10^{-3}	[3]
Bulk graphene (Electrochemically reduced)	2.8×10^{-3}	[3]
Bulk graphene (Chemically reduced)	3.9×10^{-3}	[3]
Graphene oxide (GO)	5.43×10^{-5}	[3]
H_2SO_4-G	0.0122 ± 0.0096	In this study
H_3PO_4-G	0.0305 ± 0.00293	In this study


(A)
(a) - 10 mV/s
(b) - 25 mV/s
(c) - 50 mV/s
(d) - 100 mV/s
(e) - 200 mV/s
Akım / µA
Potansiyel / V
(B)
(a) - 10 mV/s
(b) - 25 mV/s
(c) - 50 mV/s
(d) - 100 mV/s
(e) - 200 mV/s
Akım / µA
Potansiyel / V

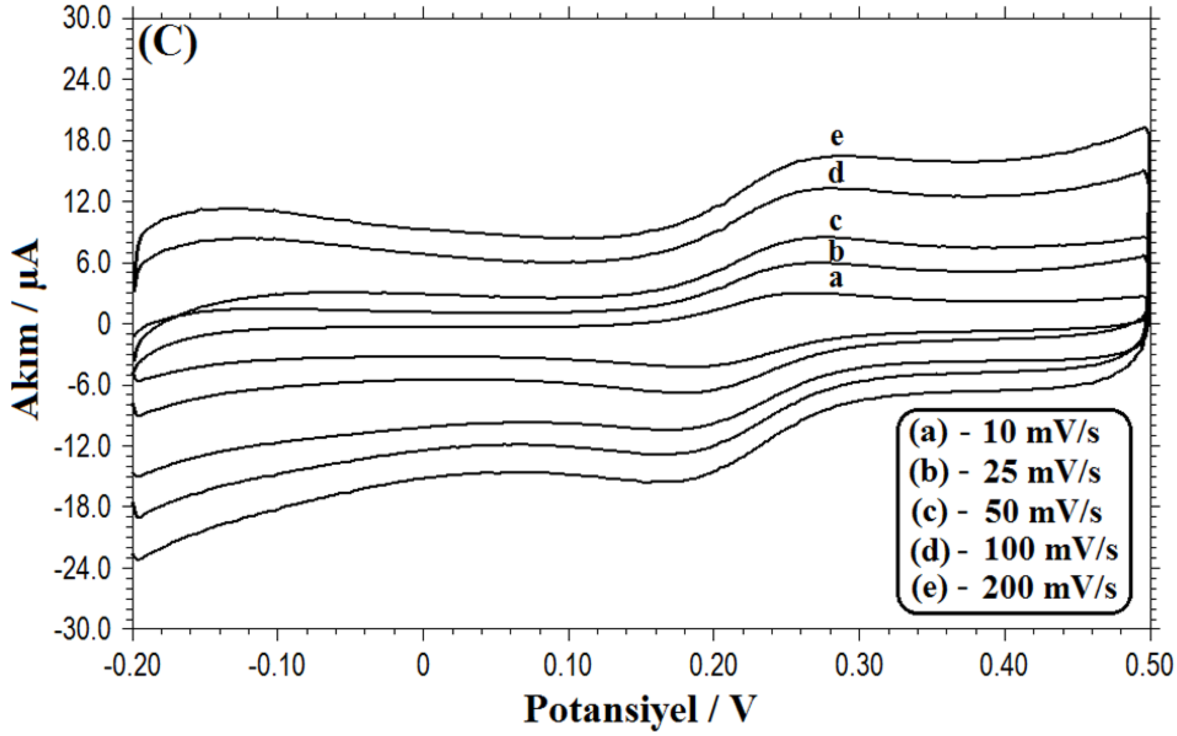


Figure S1. Cyclic voltammograms of 1.0 mM ferricyanide in 1.0 M KNO_3 at various scan rates on H_2SO_4-G (A), H_3PO_4-G (B) and $NaBH_4$-G (C) modified electrodes

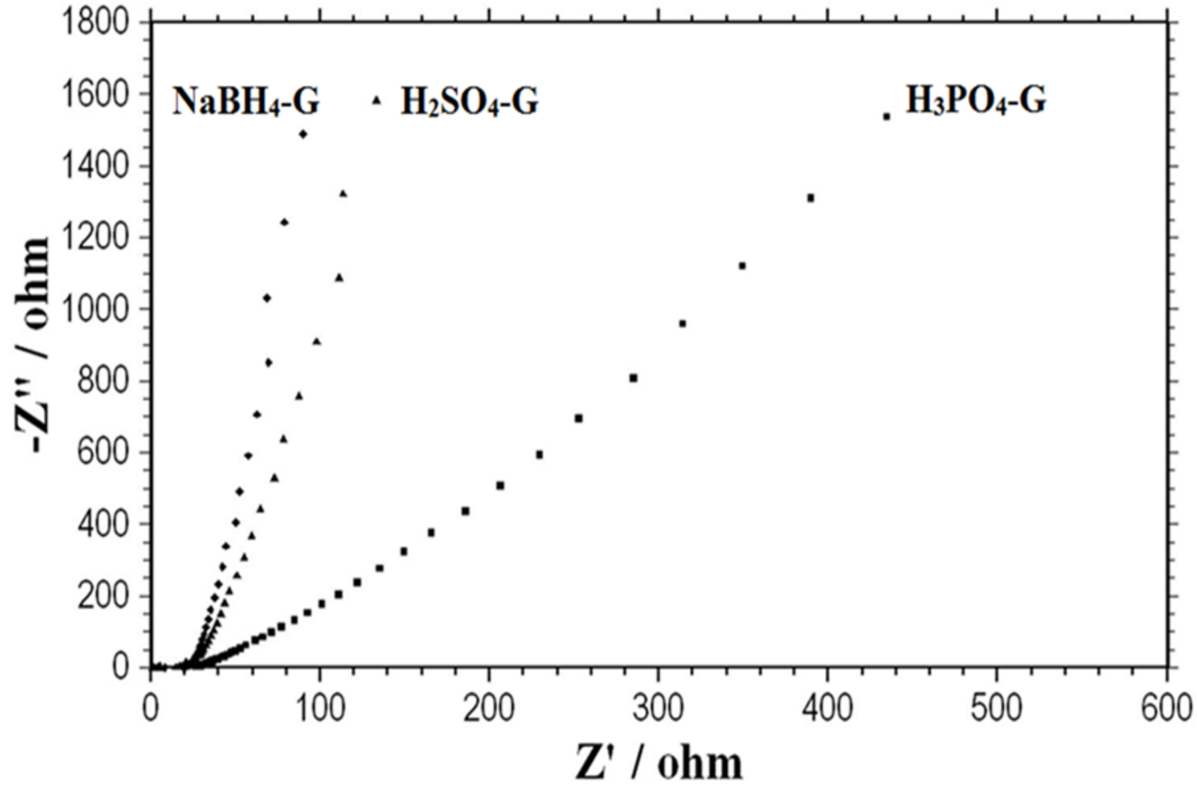


Figure S2. Electrochemical impedance spectra of graphene samples obtained at frequencies of 100,000 to 1 Hz in 1.0 M KCl.

Capacitance property of an electrode can be described with steepness of the impedance plots. The ideal situation for a capacitor is 90°. The angle is much steeper for $NaBH_4$-G compared to other two materials namely H_2SO_4-G and H_3PO_4-G shown in Figure S2. The suitability of a material for the electrochemical applications is inversely related to its capacitance feature. Therefore it can conveniently be claimed that H_3PO_4-G is the most suitable material for the electroanalytical applications.

References

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