Supporting Information

Mechanical Activation in Reduced Graphite Oxide/Boron Nitride Nanocomposite Electrocatalyst for Significant Improvement in Dioxygen Reduction

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a) Calculation of average crystallite size by using Scherrer's relation:

$$D = \frac{0.9\,\lambda}{\beta\,cos\theta}$$

Where,

D is the average crystalline size

λ is the wavelength of X-ray (1.54 Å)

θ is the Bragg diffraction angle

β the full width at half maximum (FWHM)

Table S1. **Summary of various electrochemical properties of ORR electrocatalysts**

Catalyst	E_{onset} [a)] (mV vs RHE)	$E_{1/2}$ [b)] (mV vs RHE)	$\lvert J_L \rvert$ [c)] (mA cm^{-2})	Mass activity [d)] (mA mg^{-1})
Bare h-BN	750	510	2.3	19.2
GO-BM	775	640	1.9	23.3
GOBN2	830	677	3.5	54.5
GOBN1-BM	865	715	4.05	85
GOBN2-BM	**890**	**740**	**4.4**	**114.3**
GOBN3-BM	875	720	4.05	103.5
GOBN5-BM	860	710	3.8	73.3
GOBN10-BM	860	710	3.85	105

Table S1. [(a)] The onset potential; [(b)] half-wave potential; [(c)] observed limiting current density at 0.1 V versus RHE with rotation rate of 1600 rpm; and [(d)] mass activity comparison of various nanocomposite catalysts along with bare h-BN and bare GO after mechanical activation (GO-BM).

Fig. S1 SEM image of GOBN2-BM composite catalyst

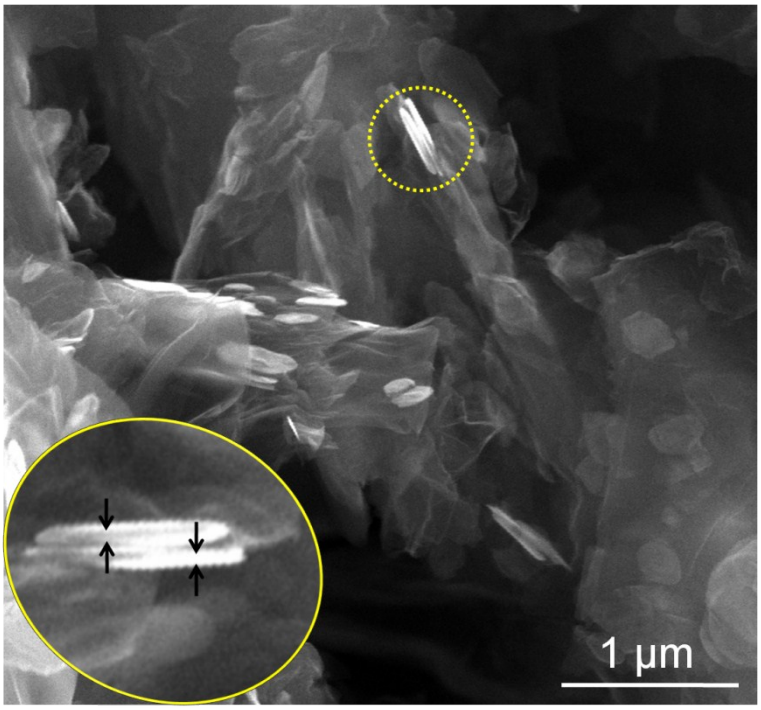

Fig. S1 SEM image of GOBN2-BM composite catalyst and inset shows the thickness of 40-60 nm of a single h-BN disk obtained by zooming the dotted yellow circle.

Fig. S2 TEM of bare graphite oxide (GO) after mechanical activation

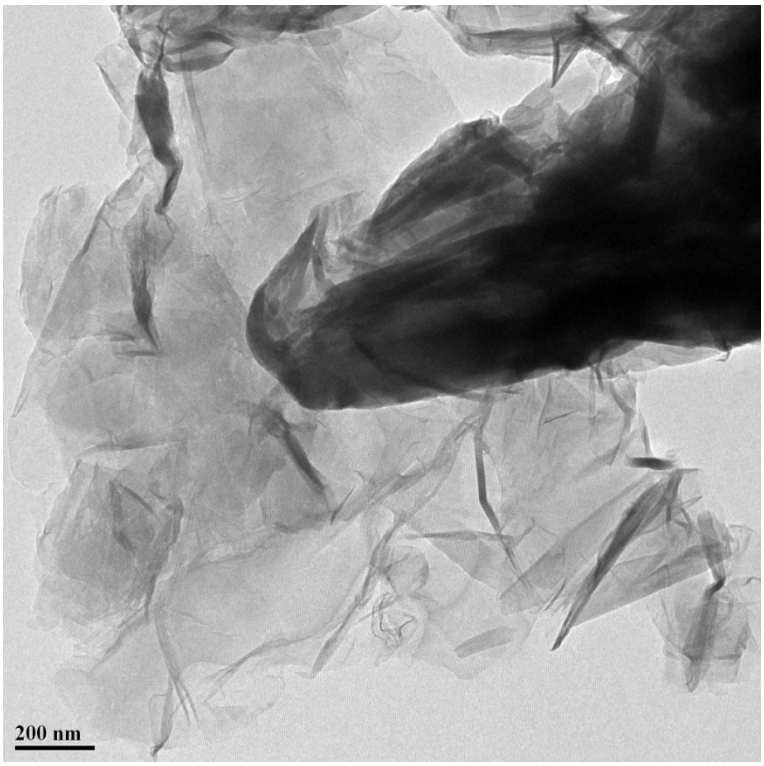

Fig. S2 Low resolution TEM image of GO-BM, displaying cut off sheets of GO during ball milling.

Fig. S3 XP spectra of GOBN2-BM sample

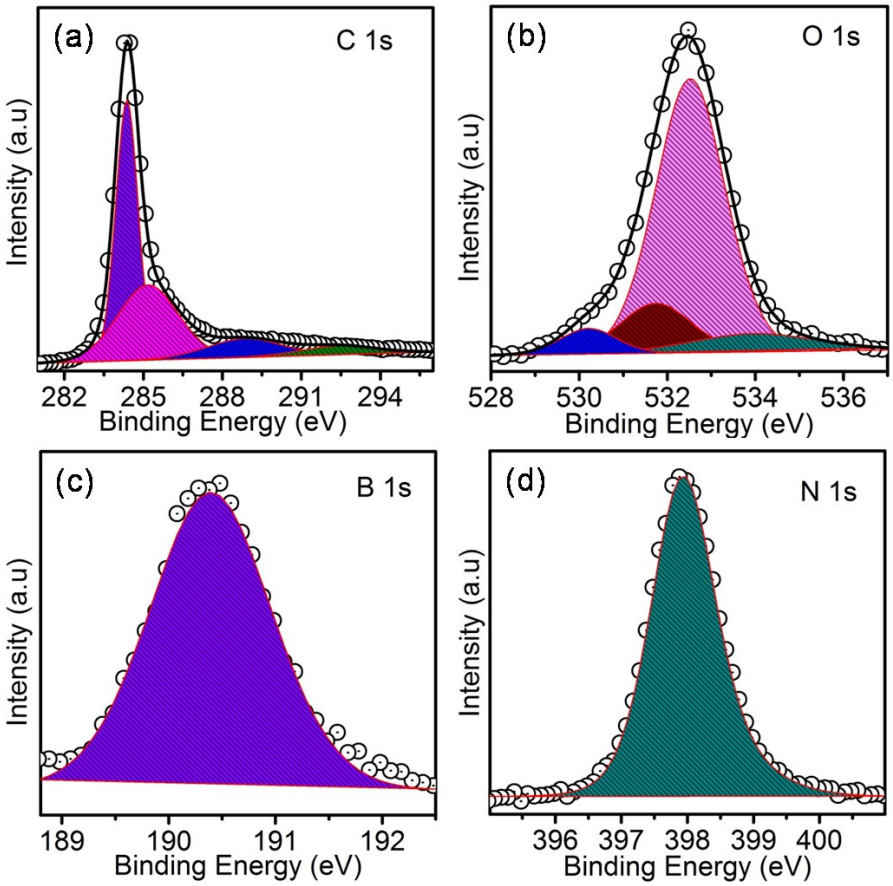

Fig. S3 XPS deconvoluted core level spectrum for (a) C 1s; (b) O 1s; (c) B 1s; and (d) N 1s exhibiting various chemical environments of C, O, B and N elements respectively; circles and solid indicate raw data and fitting curves respectively.

Fig. S4 Koutecky-Levich (K-L) plot for various electrocatalysts

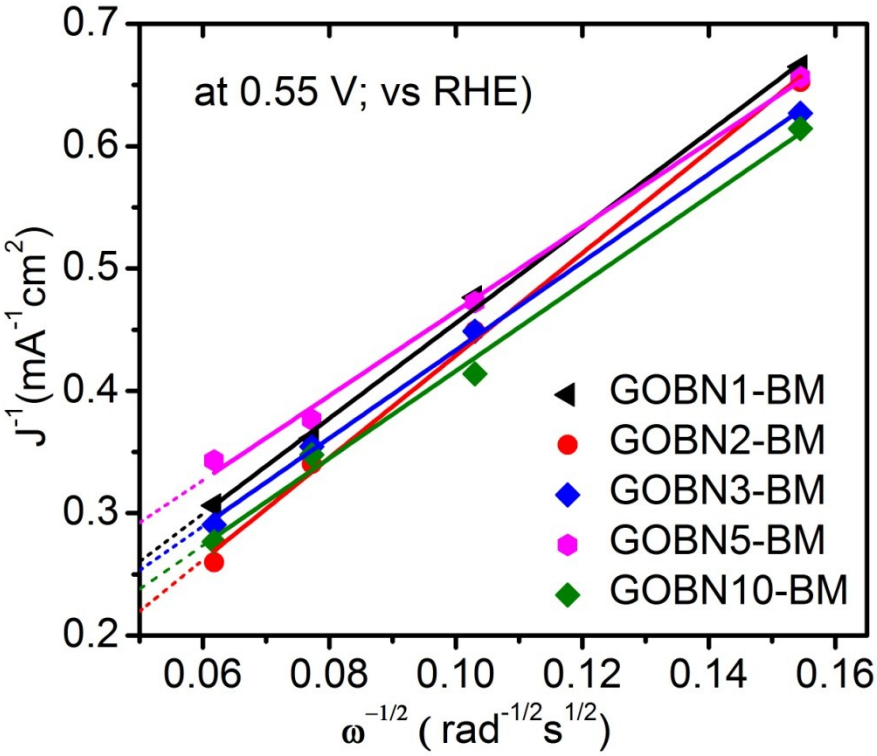

Fig. S4 Koutecky-Levich (K-L) plot for different nanocomposite catalyst derived from RDE voltammograms in Fig. 4 (d) at 550 mV versus RHE.

Fig. S5 RDE voltammogram and Koutecky-Levich plot for Pt/C catalyst

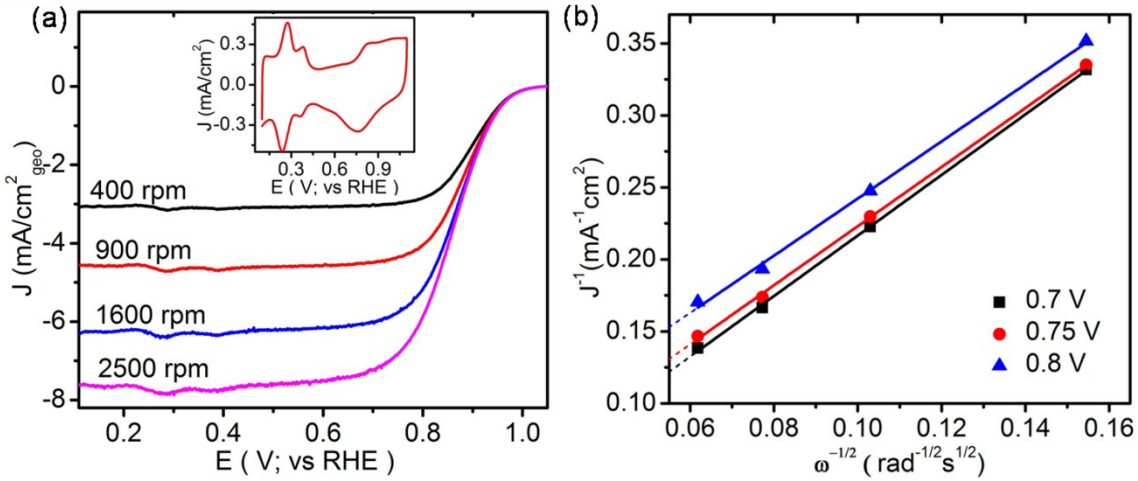

Fig. S5 (a) RDE ORR polarization curves at different rotation speed, obtained in O_2 saturated 0.1 M KOH solution at 10 mV/s; inset showing CV obtained in N_2 saturated 0.1 M KOH solution at 20 mV/s; (b) Koutecky-Levich plot derived from RDE voltammogram shown in (a) at different potentials for commercial Pt/C.

Fig. S6 RRDE voltammograms for GOBN2-BM composite catalyst

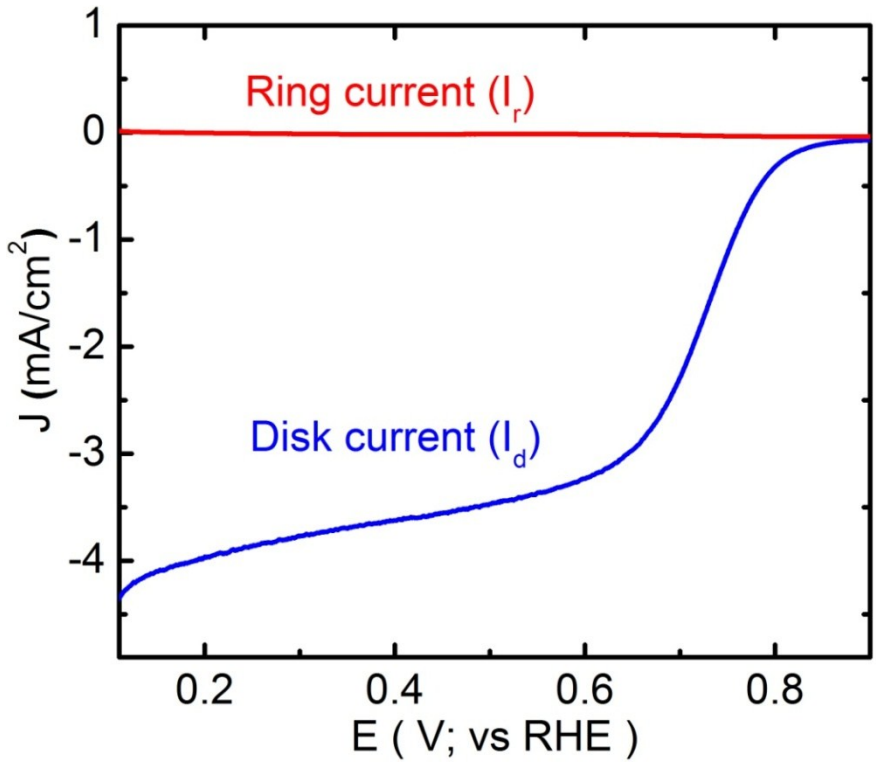

Fig. S6 The observed disk current (I_d) and ring current (I_r) for GOBN2-BM sample through RRDE study in presence of O_2-saturated 0.1 M KOH at 25°C. (rotation speed of 1600 rpm and sweep rate of 10 mV s^{-1})

Fig. S7 CVs for different nanocomposite electrocatalyst

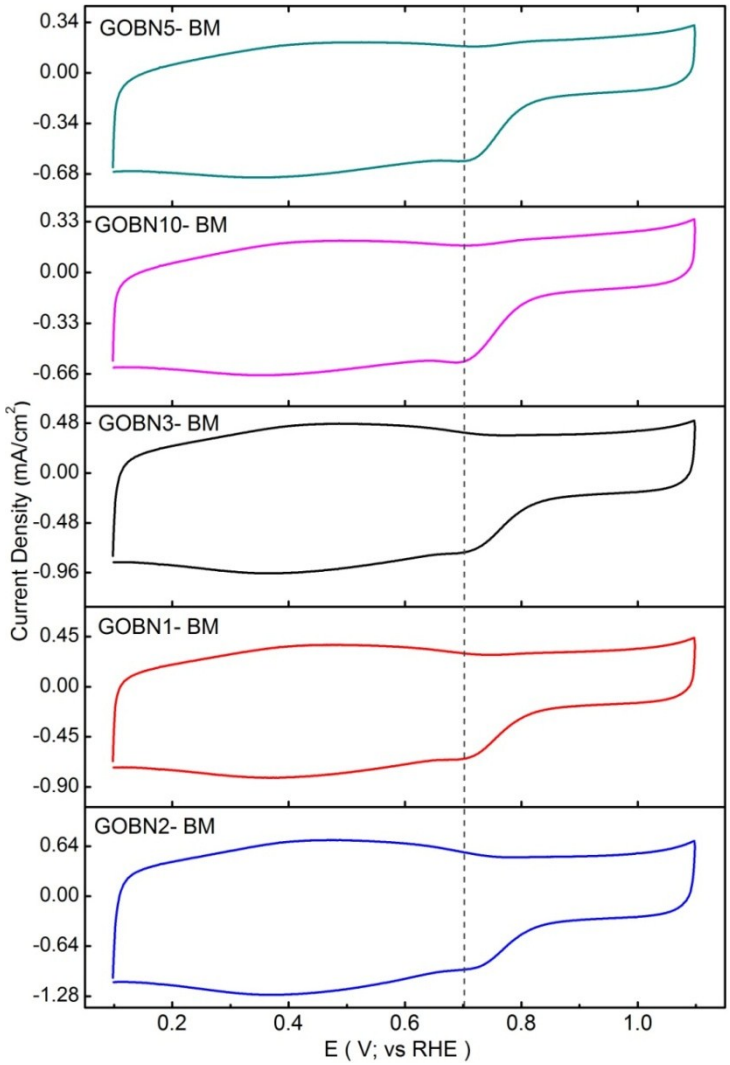

Fig. S7 Comparison of cathodic peak obtained through CVs studies of different nanocomposite catalyst at a sweep rate of 20 mV s^{-1} in O_2-saturated 0.1 M KOH electrolyte solution.

Fig. S8 Extent of peroxide yield obtained during ORR

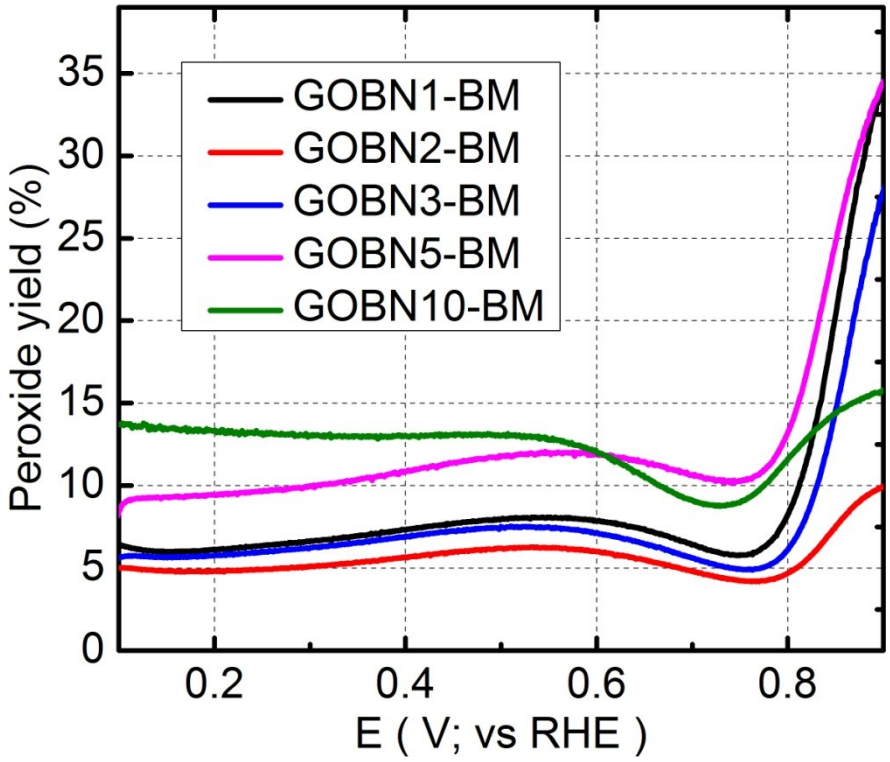

Fig. S8 The observed percentage of peroxide (HO_2^-) yield during ORR for various composite catalysts obtained through RRDE measurements.

Fig. S9 Calculated number of electron transfer during ORR

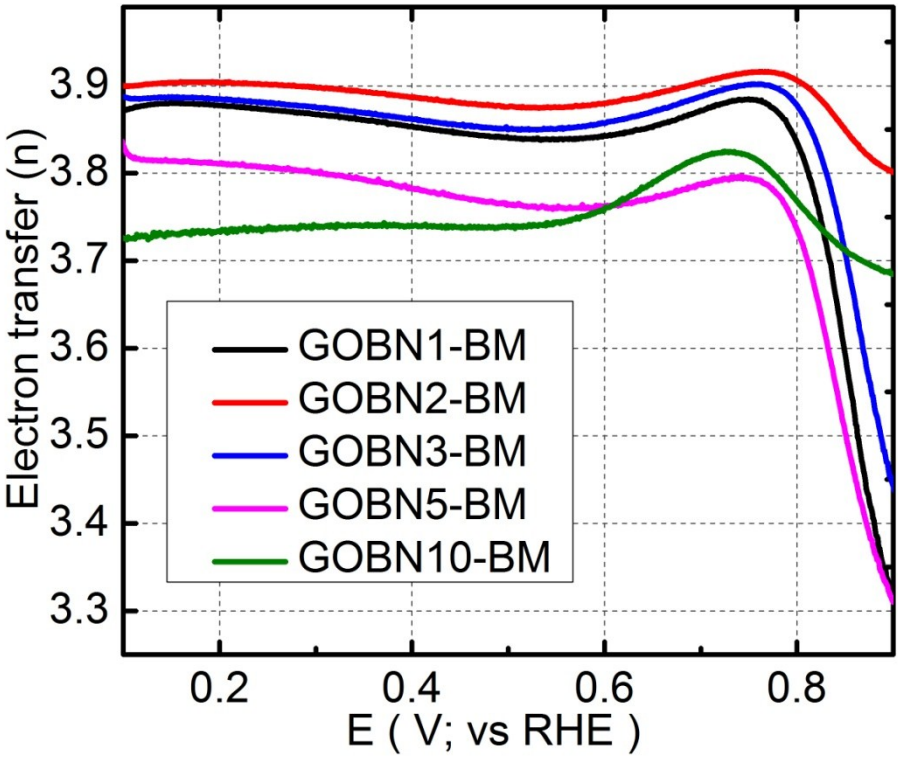

Fig. S9 The number of electron transfer (n) with respect to peroxide generated during ORR in Fig. S8 for various composite catalysts through RRDE study.