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SPIN TRANSPORT IN BN DOPED  $\text{CrO}_2$ -GRAPHENE- $\text{CrO}_2$  MAGNETIC TUNNEL JUNCTION

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## ABSTRACT

We investigate the spin-dependent electronic transport properties of Magnetic tunnel junction (MTJ) consisting of Boron (B) and Nitrogen (N) doped graphene nanosheet sandwiched between two  $\text{CrO}_2$  half-metallic-ferromagnet (HMF) electrodes. A large value of tunnel magnetoresistance (TMR) and perfect spin filtration was obtained as compared to un-doped graphene MTJ structures reported in past. The use of HMF electrodes further raises the TMR and improves the spin filtration in comparison to MTJs with metallic and ferromagnetic (FM) electrodes, which suggest HMF electrodes as a suitable candidate over metallic and FM electrodes for implementing graphene sheet based MTJs. A high value of TMR~100% is obtained at zero bias voltage, which remains constantly high at higher bias voltages in the range of 0V to 1V. The higher value of TMR and better (near perfect) spin filtration abilities suggests its usefulness in spin-valves and other spintronics based applications. The spin-dependent non-equilibrium transport is also investigated by analysing the bias dependent transmission coefficients.

## KEYWORDS

Magnetic tunnel junction (MTJ), Graphene nanosheet, Boron-Nitrogen doping, Half-metallic-ferromagnetic (HMF) electrodes, Tunnel magnetoresistance (TMR), Spin efficiency.

## INTRODUCTION

Spintronics or spin electronics refers to the utilization of electrons quantum property called spin in addition to charge and mass of an electron. The various applications of spintronic based devices in the fields like programmable logic elements, magneto-resistive random-access memory (MRAM), non-volatile information storage devices and other reconfigurable circuits make giant magneto-resistance (GMR) and tunnel magneto-resistance (TMR) effects in spintronics an attractive field to study [1] [2]. In a basic magnetic tunnel junction (MTJ) device, a thin tunnel barrier separates two ferromagnetic (FM) layers which act as source and drain electrodes. The magnetic configurations (parallel or antiparallel) of the two electrodes can be controlled by imposing an external magnetic field, thereby changing the electrical resistance of the MTJ [2] [3]. Therefore, the tunneling current for the two configurations is different which gives rise to TMR effect. Due to spin-dependent tunneling, a high conductance in case of parallel configuration (PC) and low conductance in antiparallel configuration (APC) of two electrodes is obtained [4].

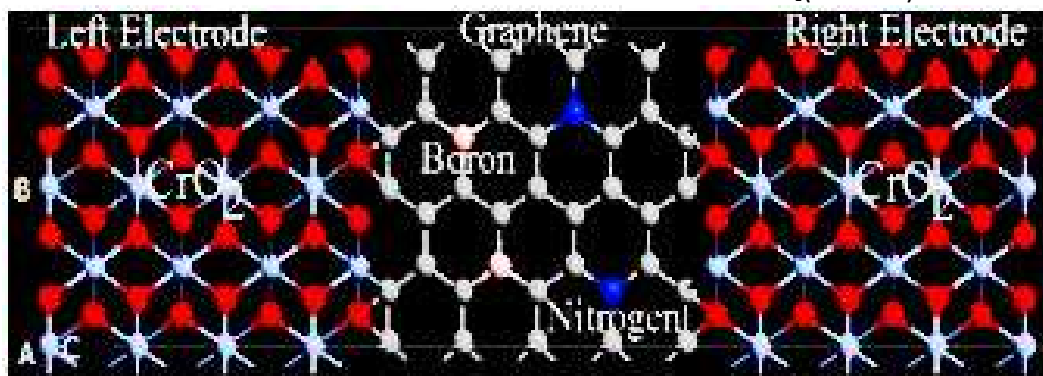
The effectiveness of a spintronic device depends on the spin polarization of the tunneling current. To ensure highly spin-polarized current source, use of half-metallic-ferromagnetic (HMF) electrodes has been suggested in [5] [6] and in several other research works. By using HMF electrodes, a large value of magnetocurrent ratio, high TMR and efficient spin filtration were obtained in [5]. In [6], a silicon (Si) channel based spin-MOSFET with HMF source and drain electrodes is demonstrated. The high value of TMR is necessary for using the structure in spin-valves and other spintronic based devices.

In MTJ, the tunnel barrier sandwiched between the ferromagnetic electrodes generally consists of metal oxides. Various theoretical and practical investigations have been conducted on MTJs using metal oxides like  $\text{Al}_2\text{O}_3$ ,  $\text{MgO}$ ,  $\text{HfO}_2$  and  $\text{Y}_2\text{O}_3$  [4], but the presence of material inter-diffusion and the defects in such oxides limit their performance [7] [8]. Recent studies have proposed to use graphene as a viable alternative to metal oxides as tunnel barriers. Graphene has gained noticeable attention due to its excellent in plane charge and spin transport properties [7]. The long electronic mean path, low spin orbit coupling, spin relaxation mechanism and extraordinary carrier mobility of graphene increases its utility in spintronics based applications [7-10]. Recent simulations of first graphene based MTJ [11] suggests that the use of graphene in spintronic devices can lead to large TMR. Graphene based MTJ demonstrated in [7] shows that improved spin-polarized current is obtained by using graphene as tunnel barrier in place of metal oxides.

The effect of Boron (B) and Nitrogen (N) co-doping in graphene sheets results in bandgap opening [12-14]. The bandgap opening is useful for implementing graphene based switches and other devices. Therefore, it is of interest to study the effects of BN co-doping on spin transport in graphene based MTJs with HMF electrodes. In this paper, we investigate the spin-transport properties of BN co-doped  $\text{CrO}_2$ -Graphene- $\text{CrO}_2$  MTJ and compare it with pristine graphene based MTJ.

## SIMULATION METHOD AND SETUP

A two-probe geometry of MTJ using BN co-doped graphene nanosheet as tunnel barrier and  $\text{CrO}_2$  as left and right HMF electrodes is built [see Fig. 1] and is simulated to obtain I-V characteristics and transmission spectra for parallel (PC) as well as antiparallel configuration (APC).

FIG. 1: MTJ CONSISTING OF BN CO-DOPED GRAPHENE NANOSHEET SANDWICHED BETWEEN  $\text{CrO}_2$  (LEFT-RIGHT) HMF ELECTRODES

The software package used for the simulation is Atomistix toolkit [15] which utilizes self-consistent calculations based on the combination of non-equilibrium Green's functions (NEGF) and density-functional theory (DFT) to realize the quantum transport properties of materials and devices. Since the I-V characteristics are a consequence of spin-polarized electron transport, therefore the exchange correlation considered in the simulations is spin-polarized generalized-gradient-approximation (SGGA).

In the simulations, graphene nanosheet with C-C bond length of 1.42 Å [16] and width (along the central region) 9.844 Å is used [see Fig. 1]. Left and right HMF electrodes are assumed to be perpendicular to graphene nanosheet and are made up of  $5 \times 5 \times 5$  CrO<sub>2</sub> layers. The spacing between graphene nanosheet and CrO<sub>2</sub> HMF electrodes is found by setting the designed structure to relaxation. In order to minimize the total energy of the system, Quasi-Newton geometry optimization technique is used for relaxing the system with force tolerance set to 0.05 eV/Å [2] [17] [18]. As a result of relaxation, the carbon atoms (C) of graphene nanosheet forms bond with chromium (Cr) and oxygen (O<sub>2</sub>) atoms of HMF electrodes. C-Cr and C-O bonds with bond lengths of ~2.135 Å and ~1.31 Å are formed as a result of this relaxation.

In order to obtain the I-V characteristics and transmission spectrum, the relaxed geometry is simulated using self-consistent calculations. The simulation parameters considered in the simulation are in accordance with the parameters used in [4] [17-20] and other research works. The parameters considered are as follows: The basis set used is double zeta polarized for central region as well as left and right electrodes. The k-point sampling of 3, 3 and 100 is selected in x, y and z directions. Mesh cut-off is 150 Ry and an electron temperature of 1200 K is chosen for faster self-consistent convergence. The spin of the left electrode is fixed to spin-up, while for the right electrode it is fixed to spin-up for PC and spin-down for APC.

The transmission coefficient  $T(E, V)$  indicates the probability of an electron having certain energy  $E$  to travel from one electrode to another under the influence of external bias voltage  $V$  and can be calculated by using the mathematical equation [19]:

$$T(E, V) = \text{Tr}[\Gamma_L(E, V) G^r(E, V) \Gamma_R(E, V) G^a(E, V)]$$

where  $\Gamma_{L/R}$  is the electrode coupling matrix. The spin-polarized current through the device can be calculated using transmission coefficients by the relation [2][19][21]:

$$I_{\uparrow(\downarrow)} = e/h \int T_{\uparrow(\downarrow)}(E, V) [F(E - \mu_L) - F(E - \mu_R)] dE$$

where  $T_{\uparrow(\downarrow)}(E, V)$  defines transmission coefficient for up ( $\uparrow$ ) and down ( $\downarrow$ ) spin channel,  $F$  defines Fermi-Dirac distribution and  $\mu_L(\mu_R)$  defines chemical potential of left (right) electrodes.

## RESULTS AND DISCUSSION

In Fig. 2 and Fig. 3, we compare I-V curves for pristine and BN co-doped graphene based MTJ for PC and APC. It can be seen that for PC the spin-up current ( $I_{\uparrow}$ ) in BN co-doped structure is more as compared to pristine structure in the bias voltage range of 0 V to 0.8 V, however,  $I_{\uparrow}$  is much less in case of APC for all the bias voltages in the range 0 V to 1 V. The spin-down current ( $I_{\downarrow}$ ) in the un-doped (pristine) structure is of the order of ~0.5 microamperes. When BN doping is introduced,  $I_{\downarrow}$  decreases by ~5 orders in PC, and in case of APC  $I_{\downarrow}$  decreases by ~2 orders. The total current ( $I_{\uparrow} + I_{\downarrow}$ ) in PC is much larger than the total current obtained in APC [see Fig. 2(c) and Fig. 3(c)]. The total equilibrium conductance of 0.196G<sub>0</sub> is obtained in BN doped structure and 0.31G<sub>0</sub> in pristine structure for PC, however, for APC these values are 0.000043G<sub>0</sub> and 0.034G<sub>0</sub>, where conductance quantum  $G_0 = 2e^2/h$  [2].

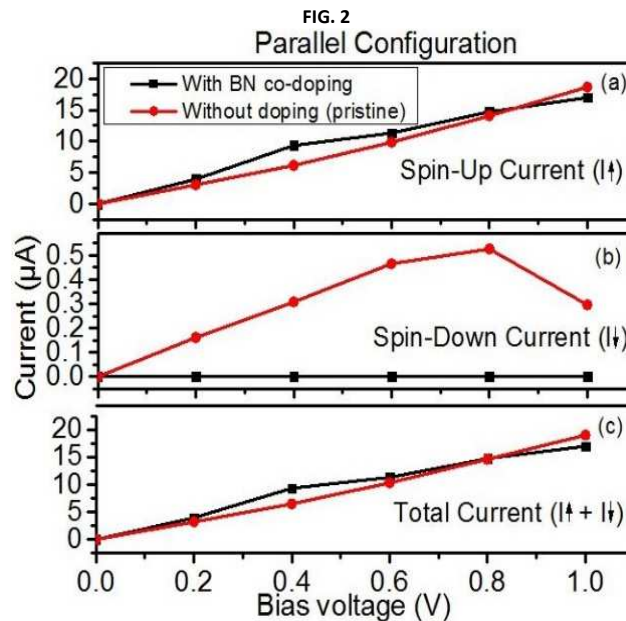


Fig. 2. I-V curves showing comparison of tunneling current between pristine and BN co-doped graphene based MTJ for parallel configuration (PC). (a)  $I_{\uparrow}$  in doped structure is slightly more than  $I_{\uparrow}$  in pristine (un-doped) structure in the bias range of 0 V to 0.8 V. (b)  $I_{\downarrow}$  is much larger in un-doped structure. (c) Total current (sum) in doped structure is slightly less than the current in un-doped structure at higher bias voltages (after 0.8 V).

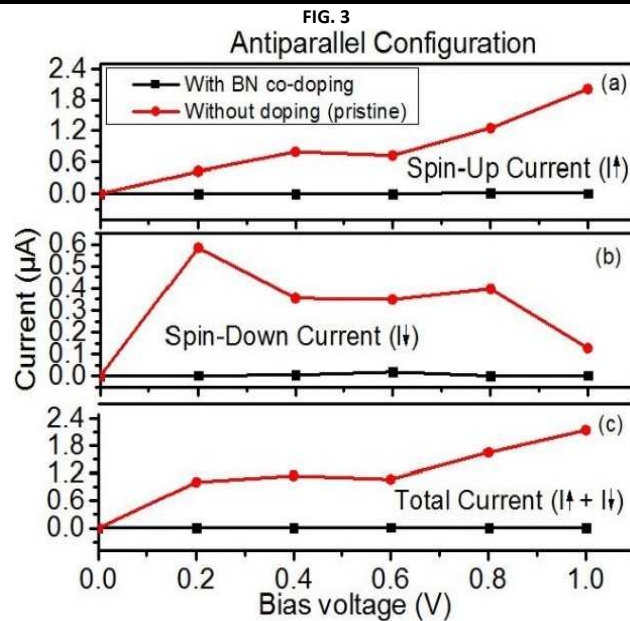


Fig. 3. I-V curves showing comparison of tunneling current between pristine and BN co-doped graphene based MTJ for antiparallel configuration (APC). (a)  $I_{\uparrow}$  is larger in un-doped structure. (b)  $I_{\downarrow}$  is larger in un-doped structure. (c) Total current (sum) is larger in un-doped structure.

From the I-V plots shown in Fig. 2 and Fig. 3, TMR vs. bias voltage plot is obtained [see Fig. 4] as per the common definition [2]:  $\text{TMR} = (I_{\text{PC}} - I_{\text{APC}})/I_{\text{APC}}$ . Here,  $I_{\text{PC}}$  and  $I_{\text{APC}}$  represents total currents in PC and APC, respectively. Since the current is zero at zero bias voltage ( $V_b = 0$ ), therefore, TMR at zero bias is calculated using equilibrium conductance. Fig. 4 compares the TMR values for pristine and BN co-doped graphene based MTJ, which shows that TMR of  $\sim 100\%$  can be obtained for BN co-doped structure at all bias voltages. High TMR indicates perfect tunneling magneto resistance effect is possible with this structure. On the other hand, a maximum possible TMR of  $\sim 90\%$  was obtained at a bias voltage of 0.6 V for un-doped structure. The physical reason for higher value of TMR in doped structure is the bandgap opening in BN doped graphene [12-14]. Large bandgap results in high TMR, which has also been suggested in [2] for V-doped BNNTs. High TMR in case of BN co-doped structure indicates its usefulness in spin-valves and in other spintronics based devices. Furthermore, TMR for BN co-doped structure remains constantly high (100%) at higher bias voltages. However, in [7] [8] [11], a reduction in TMR (reduced to zero) with increase in bias voltage was reported for graphene based MTJ.

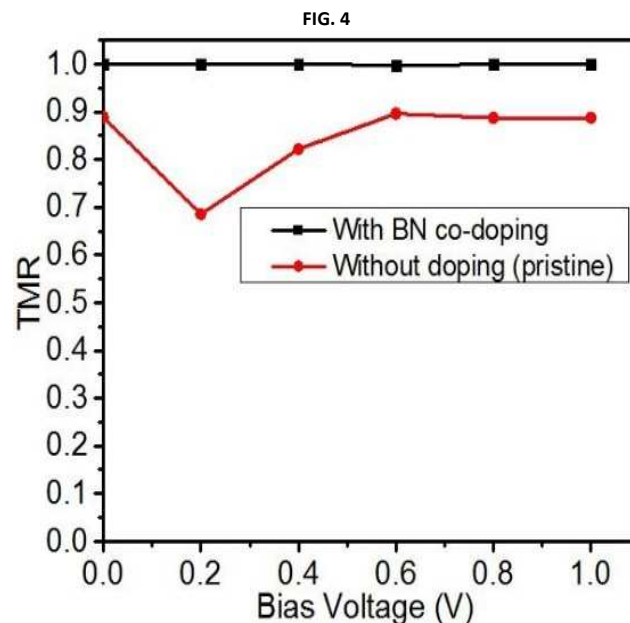


Fig. 4. TMR curves showing comparison between pristine and BN co-doped graphene based MTJ. High values of TMR  $\sim 100\%$  at all bias voltages in BN co-doped structure indicates perfect tunneling magnetoresistance effect.

From the I-V plots shown in Fig. 2 and Fig. 3, efficiency ( $\eta$ ) vs. bias voltage (V) plot is obtained as per the common definition [2]:  $\eta = (I_{\uparrow} - I_{\downarrow})/(I_{\uparrow} + I_{\downarrow})$ . The equilibrium conductance is used to calculate spin injection factor  $\eta$  at zero bias voltage. In Fig. 5, a comparison between the spin efficiency of pristine and BN doped graphene based MTJ is shown. It can be seen that for PC,  $\eta \sim 100\%$  is obtained for BN co-doped structure at all bias voltages. High efficiency indicates perfect spin filtration effect is possible with this structure. On the other hand, a maximum possible value of  $\eta \sim 98\%$  was obtained at a bias voltage of 1 V for un-doped structure. For APC, at zero bias voltage  $\eta \sim 40\%$  is obtained for BN co-doped structure. The value of  $\eta$  obtained for bias voltages in the range 0.2 V to 0.6 V is negative because of higher values of spin-down current ( $I_{\downarrow}$ ) as compared to spin-up current ( $I_{\uparrow}$ ) in this bias range. It then rapidly increases to a fairly high value of  $\sim 80\%$  at a bias voltage of 0.8 V and then decreases to  $\sim 47\%$  at 1.2 V.

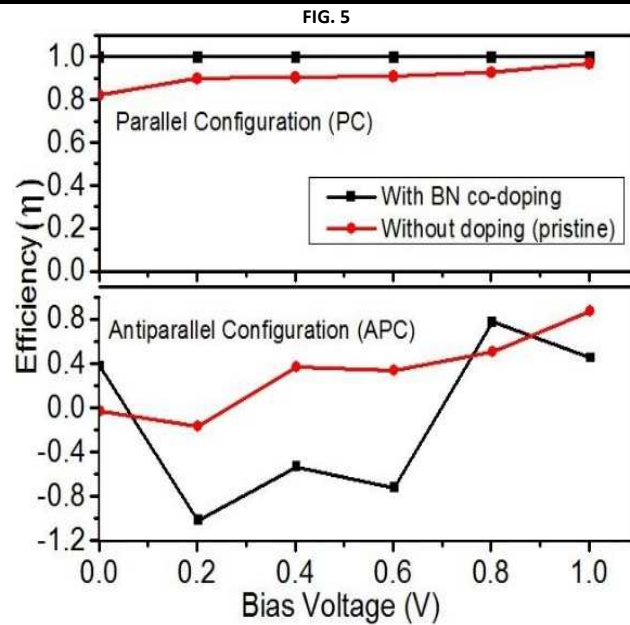


Fig. 5. Efficiency curves showing comparison of spin injection factor  $\eta$  between pristine and BN co-doped graphene based MTJ. High values of  $\eta$  indicate perfect spin filtration shown at all bias voltages in PC and at higher bias voltages in APC.

## CONCLUSION

In conclusion, the spin-dependent electronic transport properties of BN co-doped graphene based MTJ are investigated and are compared with pristine graphene based MTJ. High TMR ( $\sim 100\%$ ) and perfect spin-filtration are obtained with BN co-doped structure in comparison to the un-doped structure. High TMR in doped structure is attributed to an increase in bandgap with doping. Furthermore, high TMR and perfect spin filtration achieved in BN co-doped graphene based MTJ suggest its importance over un-doped structure in spin-valves and other spin based applications.

## REFERENCES

1. Bin Wang, Yu Zhu, Wei Ren, Jian Wang and Hong Guo, "Spin-dependent transport in Fe-doped carbon nanotubes," *Physical Review B*, vol.75, pp.235415, 2007.
2. K.L. Yao, Y. Min, Z.L. Liu, H.G. Cheng, S.C. Zhu and G.Y. Gao, "First-principles study of transport of V doped boron nitride nanotube," *Physics Letters A*, vol.372, no.34, pp.5609-5613, 2008.
3. J. Nowak and J. Rauluszkiwicz, "Spin dependent electron tunneling between ferromagnetic films," *Journal of Magnetism and Magnetic Materials*, vol.109, no.1, pp.79-90, 1992.
4. M. Chakraverty, H. M. Kittur and P. Arun Kumar, "First Principle Simulations of Various Magnetic Tunnel Junctions for Applications in Magnetoresistive Random Access Memories," *IEEE Transactions on nanotechnology*, vol. 12, no. 6, November 2013.
5. A.M.Brakovsky, "Tunneling of electrons in conventional and half-metallic systems: Towards very large magnetoresistance," *Physical Review B*, vol.56, pp.2344, 1997.
6. S. Sughara and M. Tanaka "A spin metal-oxide-semiconductor field-effect transistor using half-metallic-ferromagnet contacts for the source and drain," *Applied Physics Letters*, vol. 84, no. 13, pp. 2307-2309, 2004.
7. E. Cobas, A. L. Friedman, Olaf M. J. van 't Erve, J. T. Robinson, and B. T. Jonker, "Graphene-Based Magnetic Tunnel Junction," *IEEE Transactions on magnetics*, vol. 49, no. 7, July 2013.
8. Wan Li, Lin Xue, H. D. Abruna, and D. C. Ralph, "Magnetic tunnel junctions with single-layer-graphene tunnel barriers," *Physics review B*, vol.89, no.18, pp.184418, 2014.
9. Y. G. Semenov, K. W. Kim and J. M. Zavada, "Spin field effect transistor with a graphene channel," *Applied Physics Letters*, vol.91, no.15, pp.153105, 2007.
10. N. Kheirabadi, A. Shafiekhani, M. Fathipour, "Review on graphene spintronic, new land for discovery," *Superlattices and Microstructures*, vol.74, pp.123-145, 2014.
11. E. Cobas, A. L. Friedman, O. M. J. van 't Erve, J. T. Robinson, and B. T. Jonker, "Graphene as a tunnel barrier: Graphene-based magnetic tunnel junctions," *NanoLett.*, vol. 12, no.6, pp. 3000-3004, 2012.
12. T. P. Kaloni, R. P. Joshi, N. P. Adhikari, U. Schwingenschlögl, "Band gap tuning in BN-doped graphene systems with high carrier mobility," *Appl. Phys. Lett.*, vol.104, pp.073116, 2014.
13. Prashant P. Shinde and Vijay Kumar, "Direct band gap opening in graphene by BN doping: Ab initio calculations," *Phys. Rev. B*, vol.84, pp.125401, 2011.
14. Regiane Nascimento, Jonathan da Rocha Martins, Ronaldo J. C. Batista, and Helio Chacham, "Band Gaps of BN-Doped Graphene: Fluctuations, Trends, and Bounds," *J. Phys. Chem. C*, vol.119, no.9, pp 5055-506, 2015.
15. Atomistix, QuantumWise A/S, <http://www.quantumwise.com>
16. V. J. Surya, K. Iyakutti, H. Mizuseki, and Y. Kawazoe, "Tuning Electronic Structure of Graphene: A First-Principles Study," *IEEE Transactions on nanotechnology*, vol. 11, no. 3, 2012.
17. Sudhanshu Choudhary and S. Qureshi, "Theoretical study on the effect of dopant positions and dopant density on transport properties of a BN co-doped SiC nanotube," *Physics Letters A*, vol.377, no.5, pp.430-435, 2013.
18. Sudhanshu Choudhary and S. Qureshi, "Theoretical study on transport properties of a BN co-doped SiC nanotube," *Physics Letters A*, vol.375, no.38, pp.3382-3385, 2011.
19. Y.T. Yang, R.X. Ding and J.X. Song, "Transport properties of boron-doped single-walled silicon carbide nanotubes," *Physica B: Condensed Matter*, vol.406, no.2, pp.216-219, 2011.
20. S. Choudhary and S. Qureshi, "Theoretical study on the effect of vacancy defect reconstruction on electron transport in Si-C nanotubes," *Modern Physics Letters B*, vol.25, no.28, pp.2159, 2011.
21. Zhenyu Li and Daniel S. Kosov, "Dithiocarbamate Anchoring in Molecular Wire Junctions: A First Principles Study," *Journal of Physical Chemistry B*, vol.110, no.20, pp.9893-9898, 2006.

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