Supporting Information for:

p-type conductivity of hexagonal boron nitride as dielectrically tunable monolayer: modulation doping with magnesium

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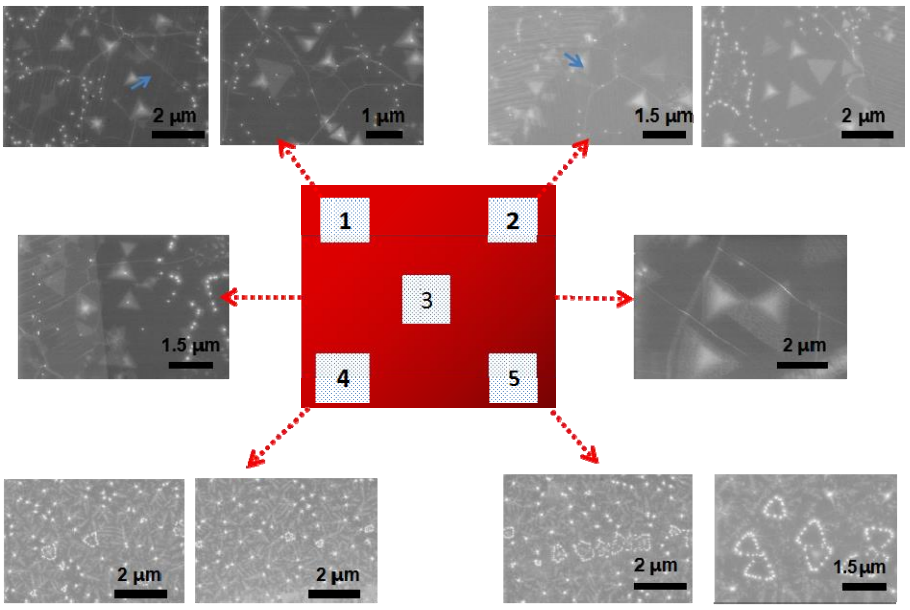

Fig. S1. SEM image of h-BN layer in different parts of Cu foil. Five representative places show the uniformity and full coverage of h-BN layer on Cu foil.

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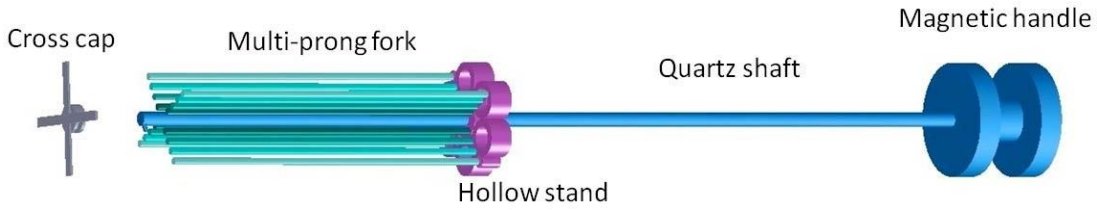

Fig. S2. Schematic of multi-prong quartz fork equipped with a magnetic handle and cross cap. The hollow stand is designed for supporting the multi-prong fork and meanwhile, maintaining a fluent gas flow through the wound Cu foil surfaces.

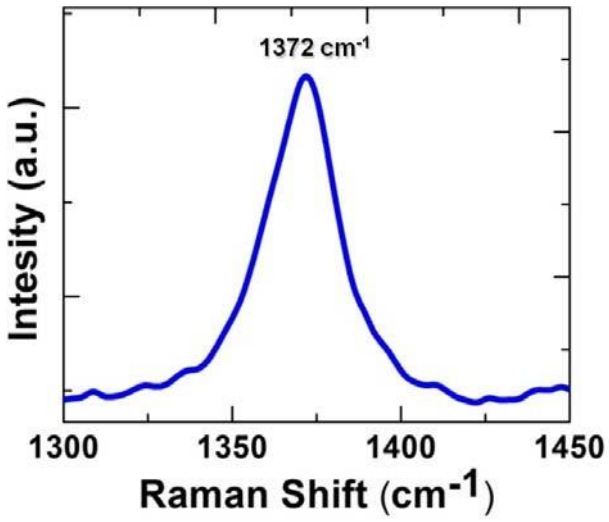

Fig. S3. Raman spectrum of monolayer h-BN transferred on SiO_2 substrate.

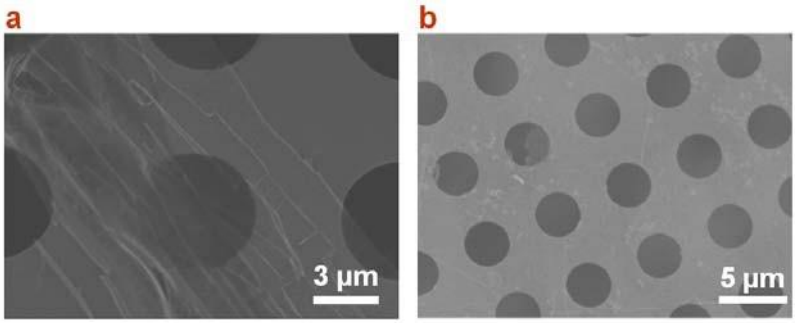

Fig. S4. SEM images of transferred h-BN monolayer on TEM grid covered with patterned carbon support film.

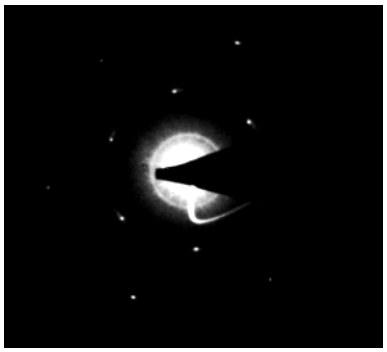

Fig. S5. SAED pattern of h-BN monolayer, showing the hexagonal structure and monolayer feature.

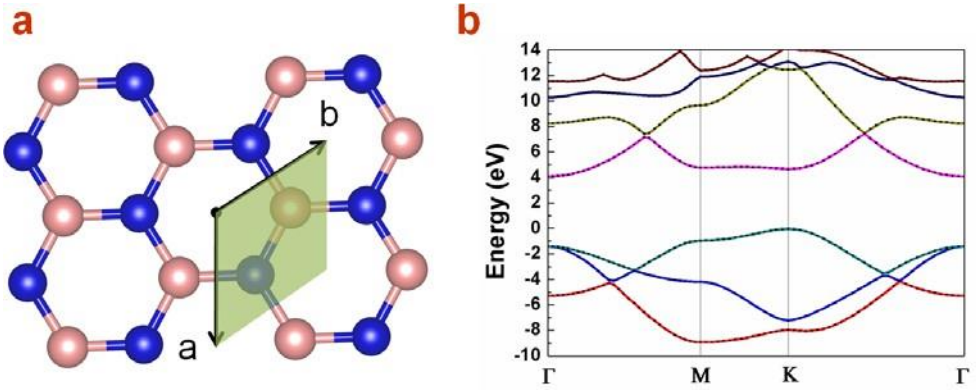

Fig. S6. (a) Atomic strucutre of undoped monolayer h-BN for first-principles calculations and (b) calculated band structure.

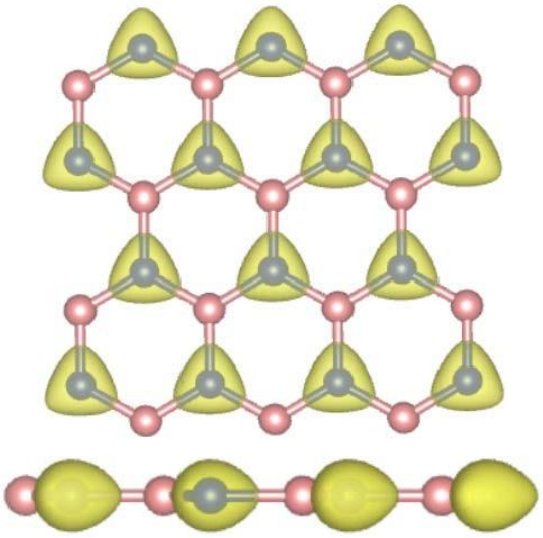

Fig. S7. Topview (up) and sideview (down) of charge distribution (VBM) superimposed on h-BN lattice.

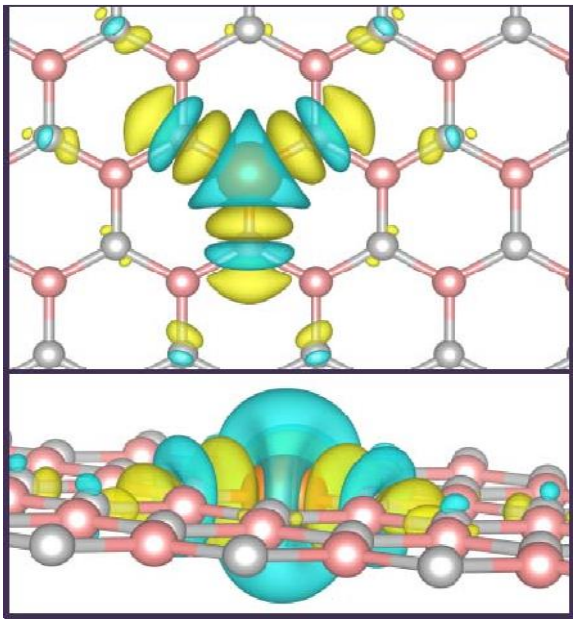

Fig. S8. Topview (up) and sideview (down) of differential charge density distribution (VBM) of Mg doped monolayer h-BN by undoped h-BN.

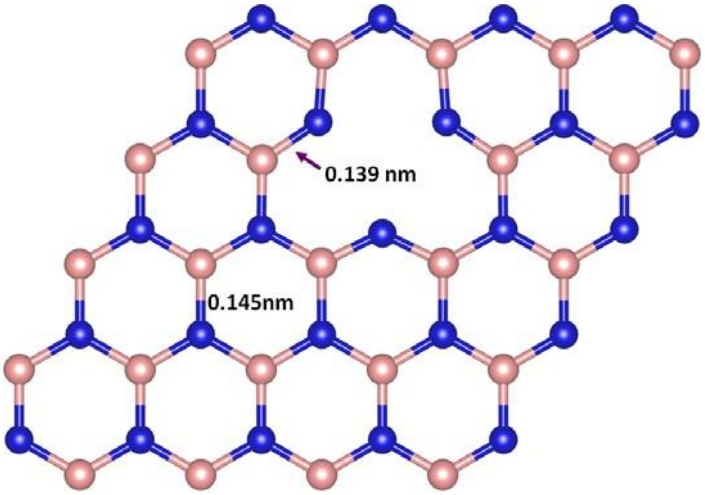

Fig. S9. Relaxed atomic structure of h-BN layer with a B vacancy. The bond length of B-N in the vacancy core shrinks to 0.139 nm, less than the original length 0.145 nm.

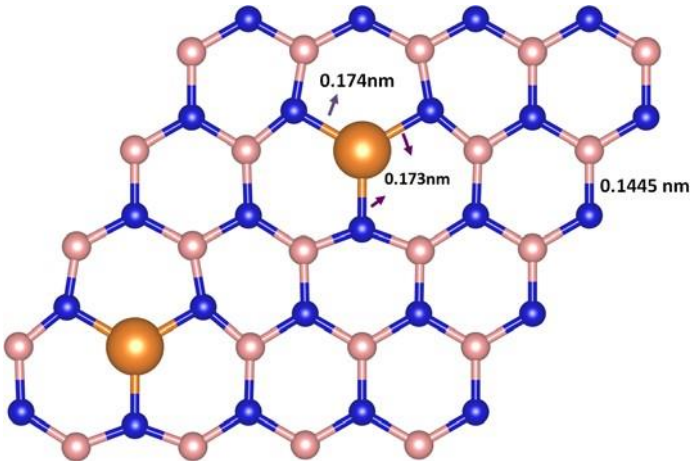

Fig. S10. Relaxed atomic structure of h-BN:Mg_2 monolayer (B_{Mg2}). The bond length of Mg-N is measured to be 0.174 nm, longer than that of B-N (0.145 nm).

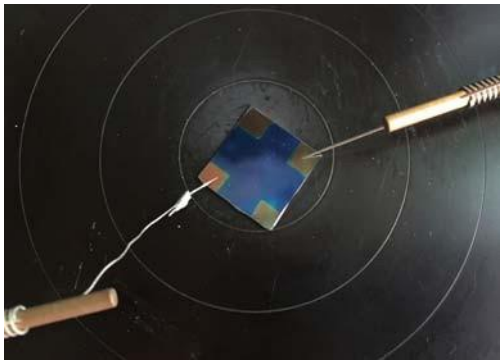

Fig. S11. Photograph of electrical measurement for h-BN:Mg sample on probe station.

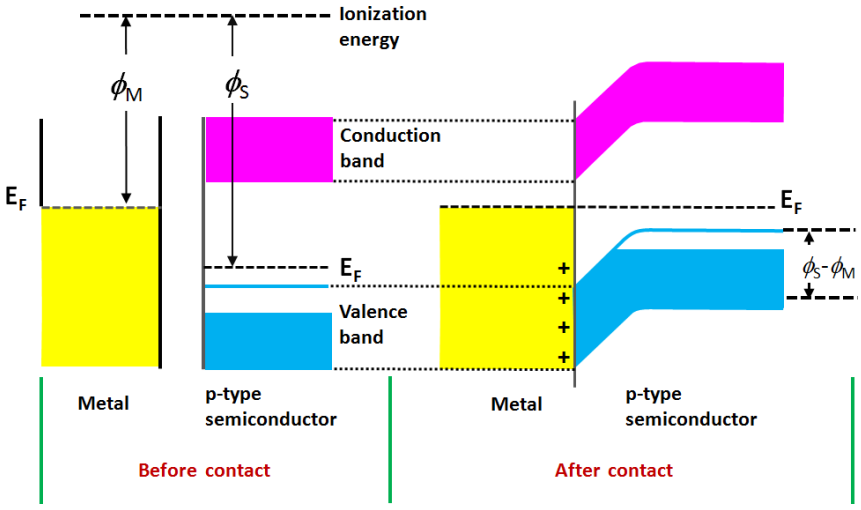

Fig. S12. Energy bands configurations of metal and p-type semiconductor before (left) and after (right) contact.

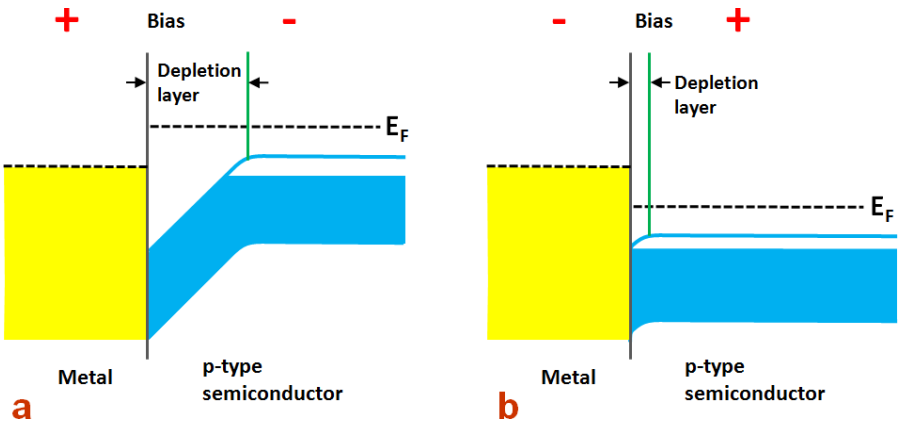

Fig. S13. Energy bands configurations of contact of metal and p-type semiconductor with two polarities: (a) V_+ bias and (b) V_- bias.

Fig. S14. Image of galvanometer when measuring the net current of h-BN:Mg monolayer with single probe rectification method. The negative net current confirms the p-type conductivity of h-BN:Mg.

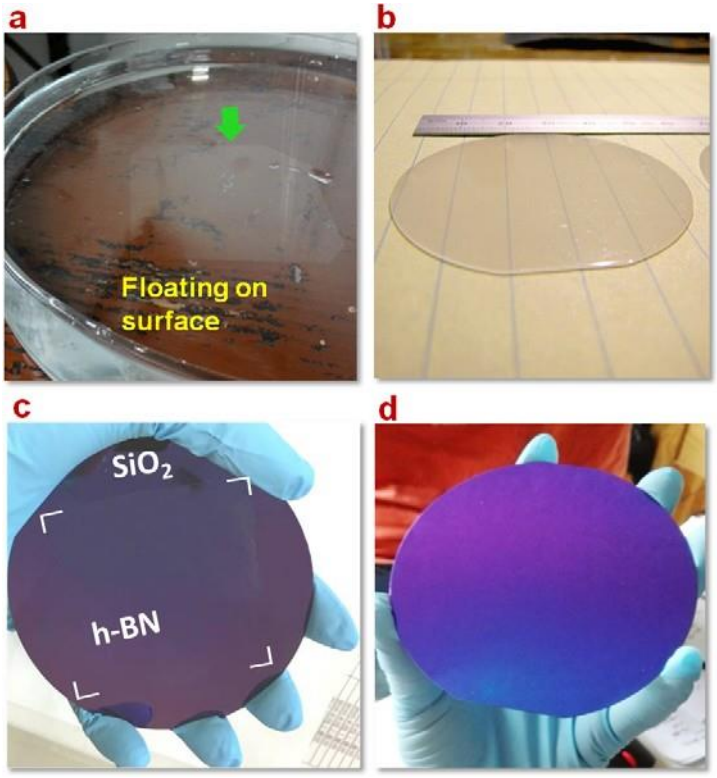

Fig. S15. Photographs of large-area h-BN transfer. (a) PMMA protected h-BN film floating on DI water surface, (b) h-BN covered 2” GaN wafer, (c) 4” Si wafer partially covered with h-BN film, and (d) h-BN fully covered 4” Si wafer.

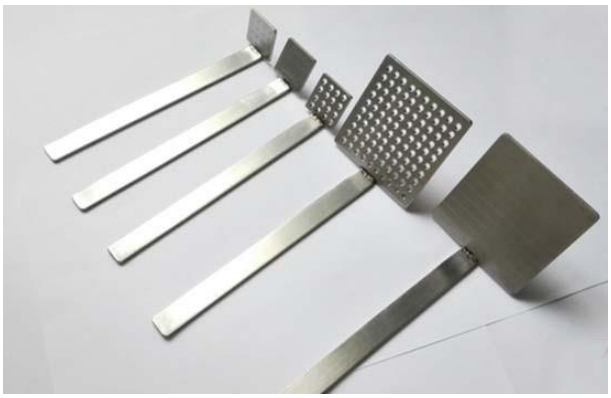

Fig. S16. Photograph of a set of home-made spade tools for h-BN film transfer.