Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

ESI for

Evolution of magnetism in Rolling up hexagonal boron nitride nanosheets tailored superparamagnetic nanoparticles

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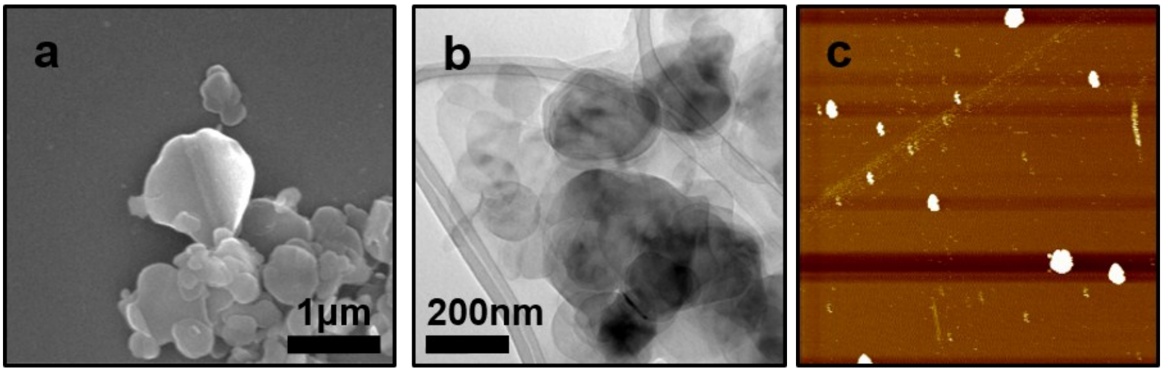
Figure S1. (a) SEM, (b) TEM and (c) AFM images of the exfoliatied boron nitride sheets.



The boron nitride in dichlorobenzene (ODCB) was homogenized at 1000 rpm for 1 hr followed by centrifugation at 4400 rpm for 30 minutes and collected from the supernatant dispersions. The concentration of the final exfoliated h-BN was calculated using the vacuum filter through a weighed membrane. The exfoliated h-BN solution had a concentration of 0.089mg/mL. SEM and TEM images of the exfoliated h-BN are shown in Figure S1a-b. The multi-layers boron nitride with the size of typically several hundred nanometers is observed. Additionally, an AFM image (Fig.S1c) shows the thickness of layers. The thickness of thinnest boron nitride is below few nm.

Figure S2. TEM images and XRD spectrum of Fe_3O_4 NPs.

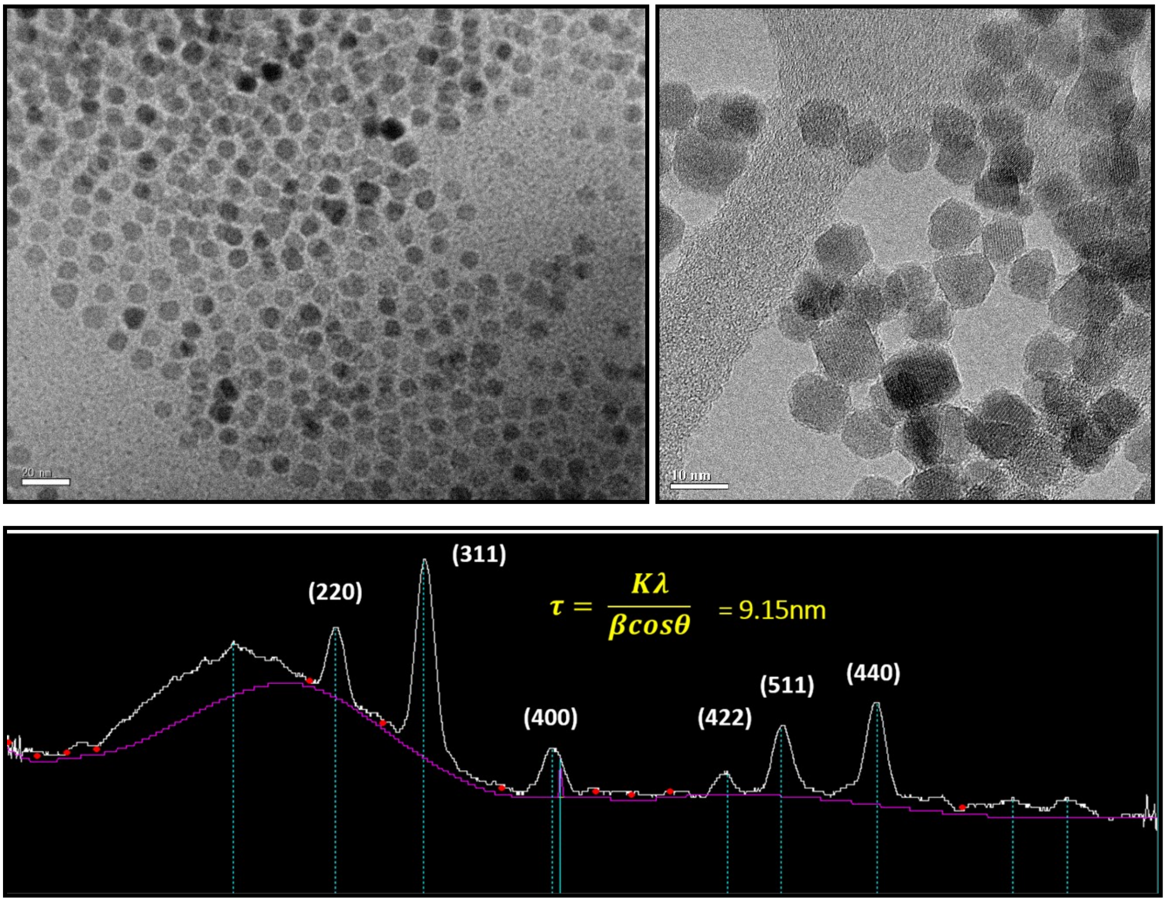
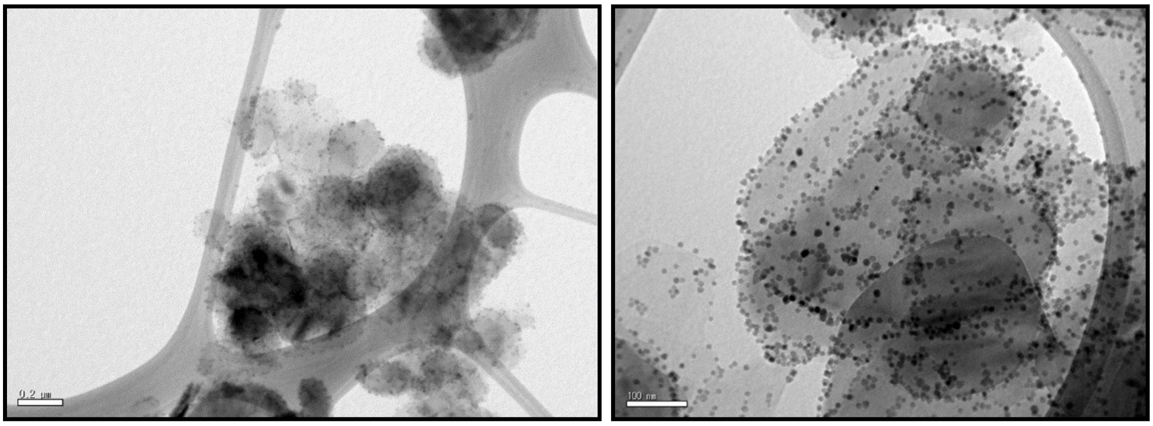


Figure S3. TEM images of h-BN-Fe_3O_4 sheets produced by the attachment of Fe_3O_4 NPs to the h-BN surface.



TEM images of the synthesized h-BN-Fe_3O_4 sheets with low magnification. Magnified TEM images of the few layer h-BN surface with homogeneous attachment of Fe_3O_4 nanoparticles with size of 9 nm.

Figure S4. Collected TEM images h-BN-Fe_3O_4 nanoscrolls (BNFS) from several samples with a diameter up to 80 nm.

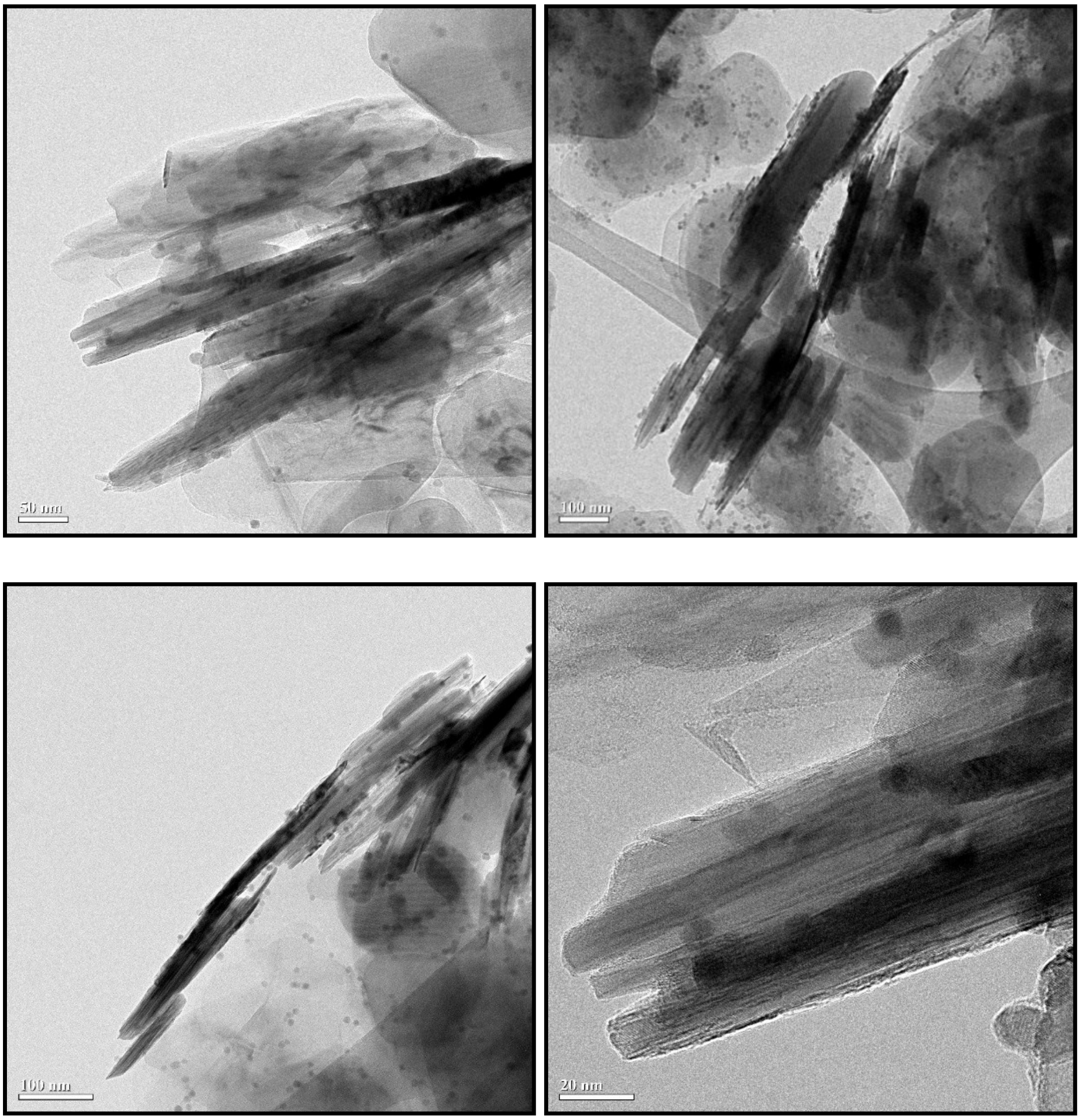
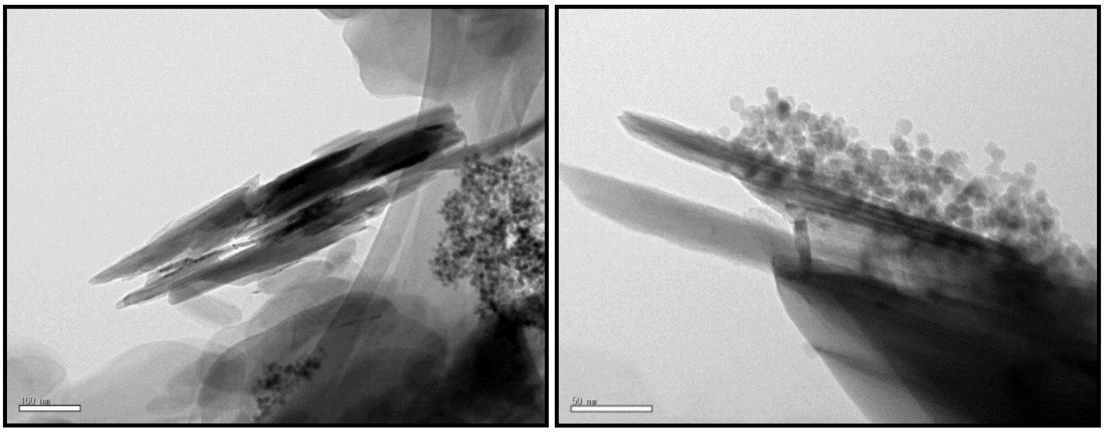
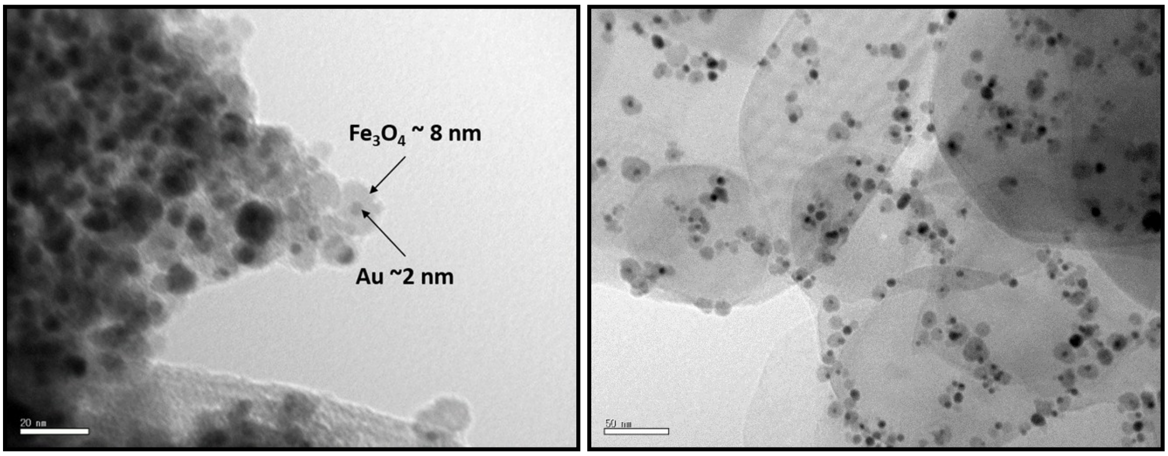


Figure S5. TEM images of h-BN nanoscrolls (BNS) and Fe_3O_4 NPs hybrids.



TEM images of the synthesized h-BN nanoscrolls (BNSs) according to the previous work[1] and hybrids with Fe_3O_4 NP solution. Magnified TEM images of the few layer BNSs with aggregation of Fe_3O_4 nanoparticles because interaction between Fe_3O_4 NPs is higher than that between Fe_3O_4 and LCA.

Figure S6. TEM images of Au@Fe_3O_4 NPs and h-BN-Au@Fe_3O_4 NPs sheets



TEM images show well dispersed Au@Fe_3O_4 NPs in solution and the synthesized h-BN-Au@Fe_3O_4 sheets with low magnification. Magnified TEM images of the few layer h-BN surface with homogeneous attachment of Au@Fe_3O_4 nanoparticles with size of 2 and 8nm, respectively.

Figure S7. Collected TEM images h-BN-Au@Fe_3O_4 nanoscrolls from several samples.

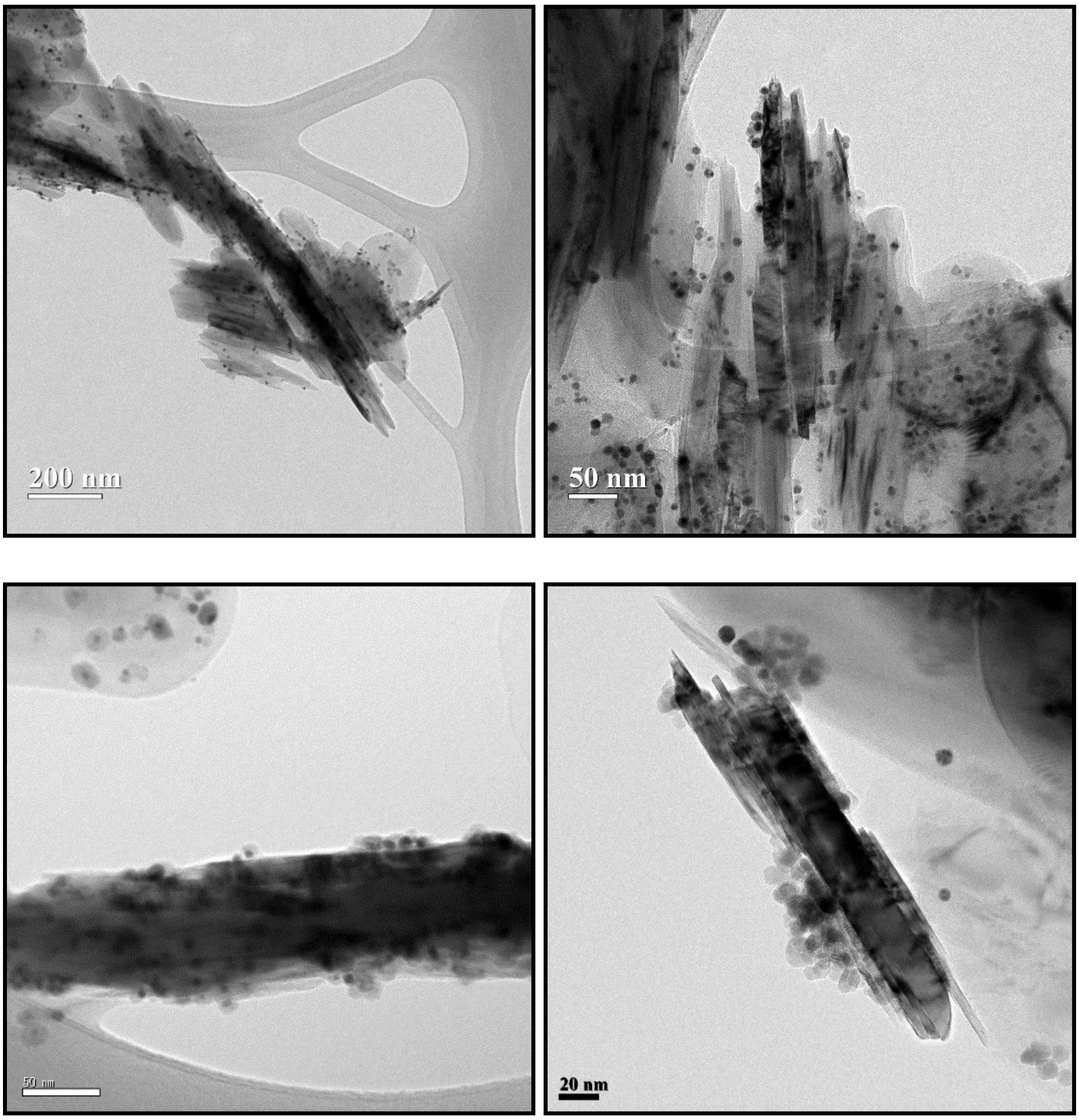


Figure S8. EDS mapping images and spectrum of h-BN-Au@Fe_3O_4 nanoscrolls for various elements (B, N, Fe, O and Au).

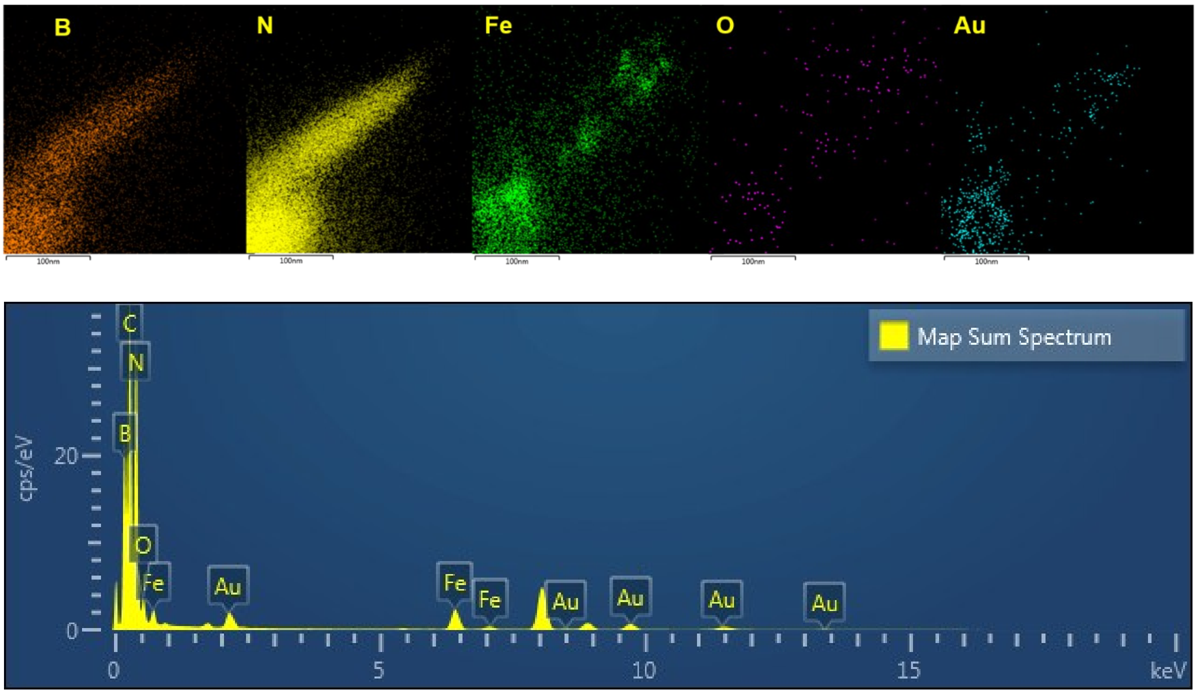
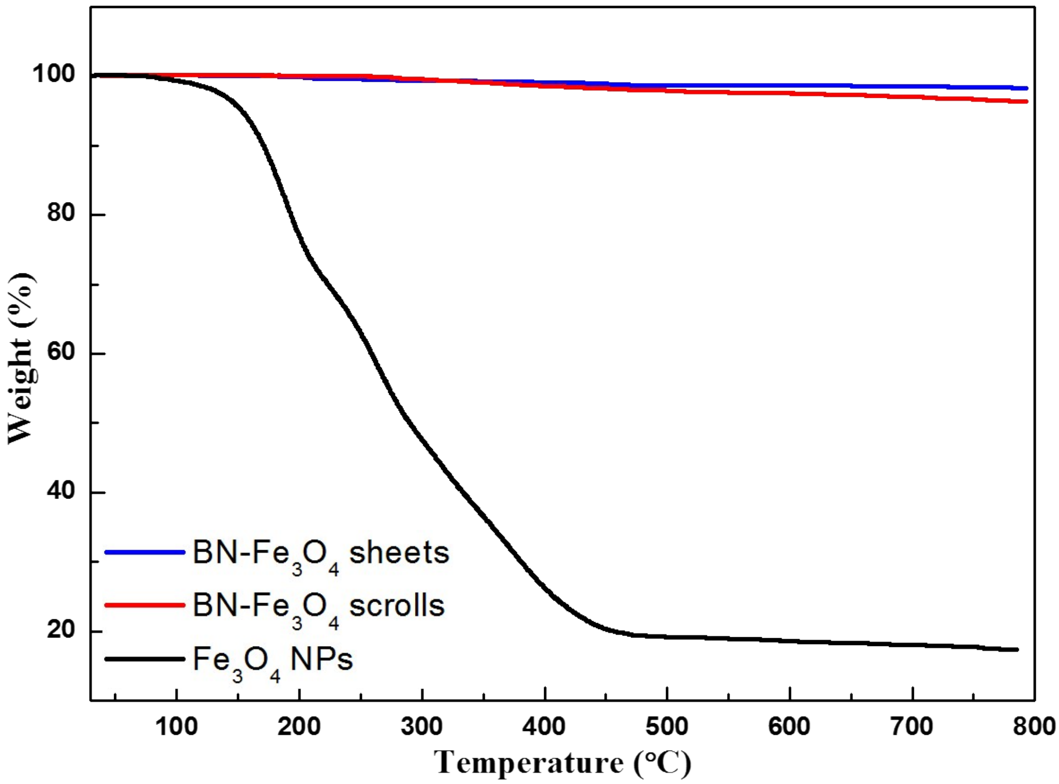


Figure S9. TGA curves for Fe_3O_4 NPs and Hexagonal boron nitride sheets and nanoscrolls with Fe_3O_4 NPs through the heat treatment. TGA curves of the Fe_3O_4 NPs (black), BN-Fe3O4 scrolls (red) and BN-Fe_3O_4 sheets (blue).



Hexagonal boron nitride derivatives were thermally treated under a N_2 atmosphere at a heating rate of 10°C/min to 800°C. The TGA curves show the thermal degradation of Fe_3O_4 NPs, BN-Fe_3O_4 scrolls and BN-Fe_3O_4 sheets. In case of Fe_3O_4 NPs, the sharp degradation at 200°C followed by 20 wt% of Fe_3O_4 NPs are observed in TGA curves. BN-Fe_3O_4 scrolls and BN-Fe_3O_4 sheets with slight reduction in the weight is stable up to 800°C. Additionally, the thermal degradation of Fe_3O_4 in BN-Fe_3O_4 scrolls and BN-Fe_3O_4 sheets begins at 300°C maintaining the shape of boron nitride sheets and scrolls.

Figure S10. Magnetization vs. magnetic field curve of boron nitride sheets and BNSs.

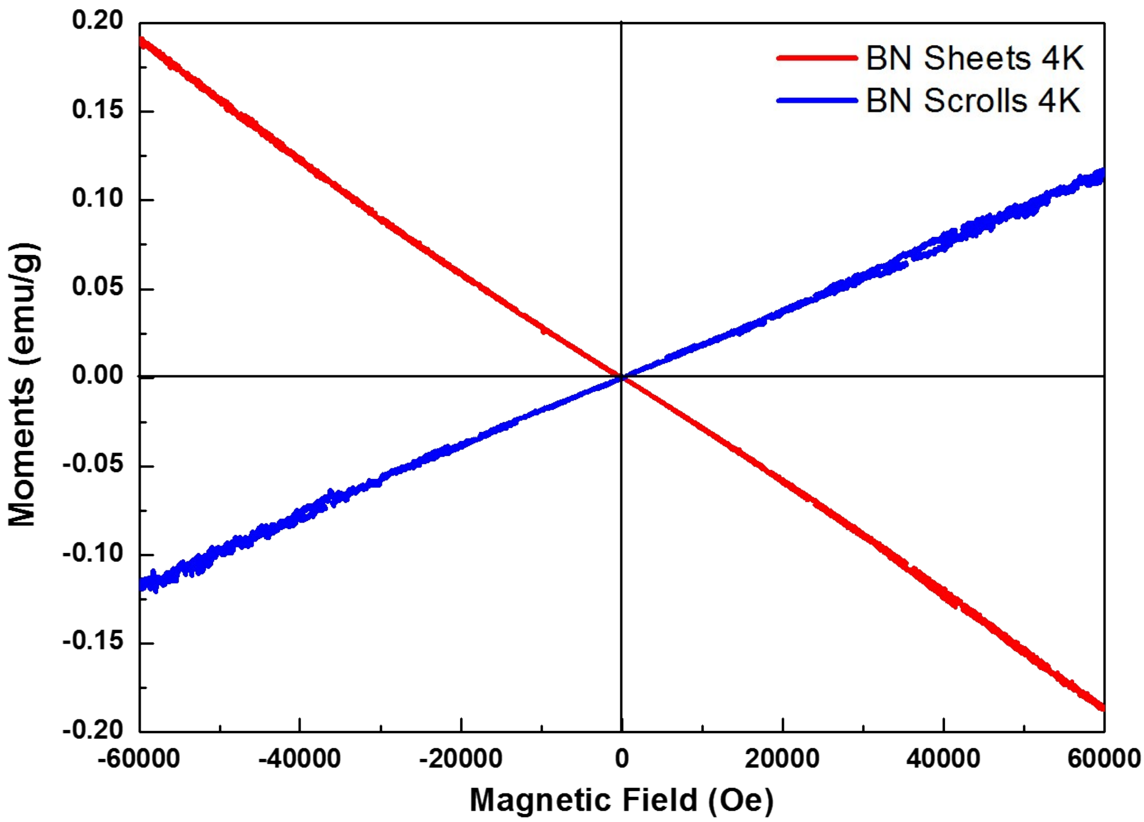


Figure S11. Magnetization vs. magnetic field curve of h-BN-Au@Fe_3O_4 sheets and their scrolls at 4 and 300K.

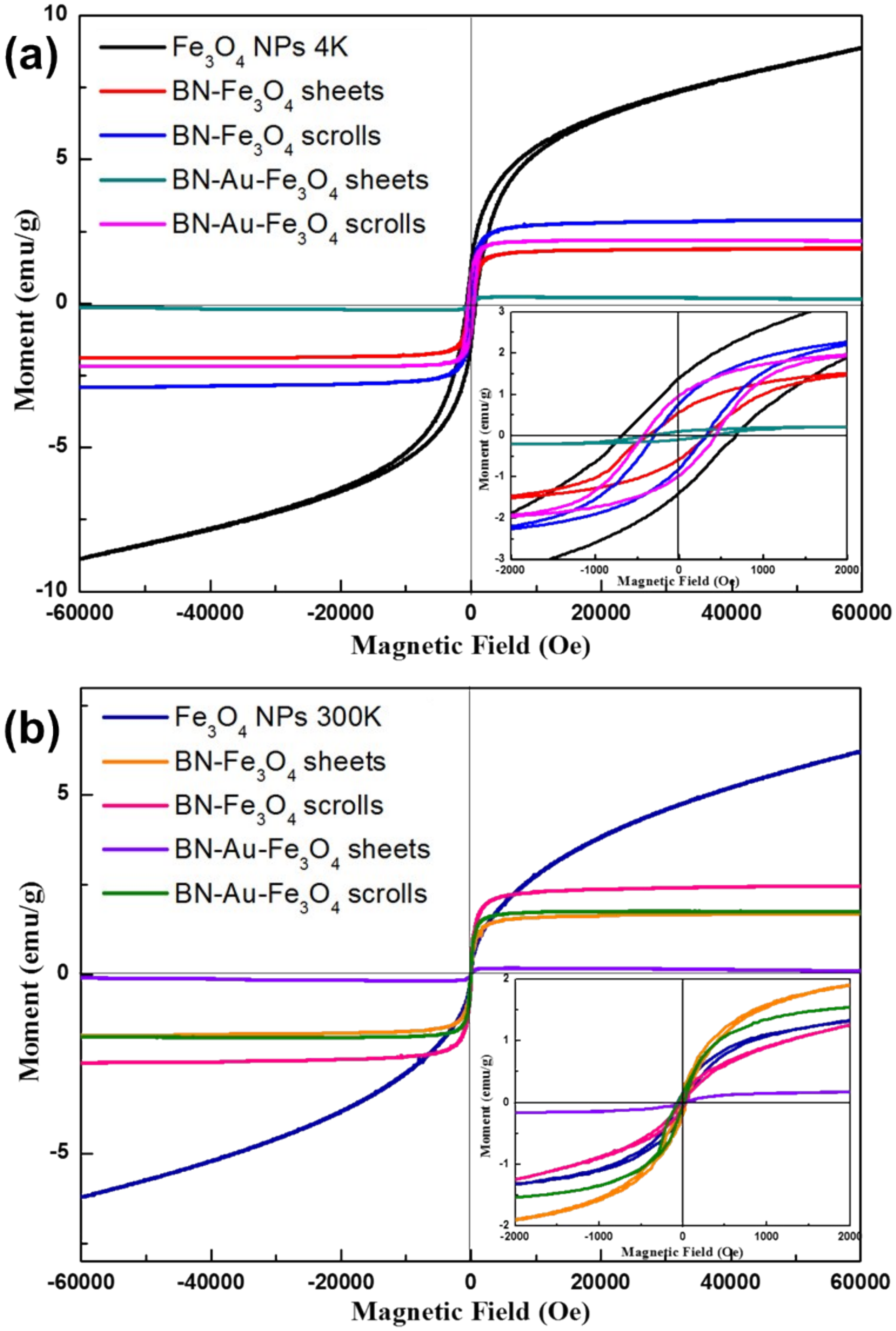
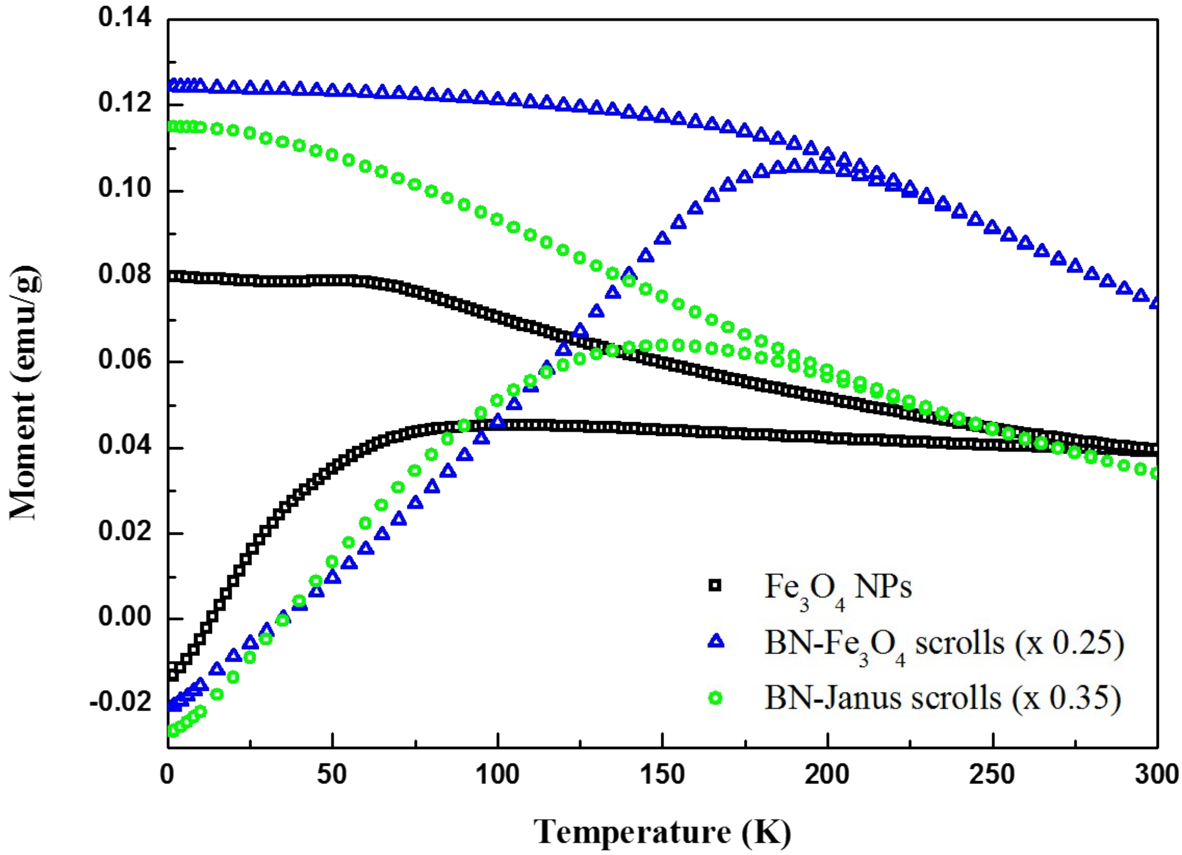


Figure S12. FC and ZFC magnetic susceptibilities versus temperature at 20 Oe for Fe_3O_4 NPs, h-BN-Fe_3O_4 nanoscrolls and h-BN-Au@Fe_3O_4 (Janus) nanoscrolls.



References

1. D. Y. Hwang and D. H. Suh, *Nanoscale*, 2014, **6**, 5686-5690.