Electronic Supplementary Material (ESI) for RSC Advances.

Supporting data

1.AFM of graphene/FINEMET

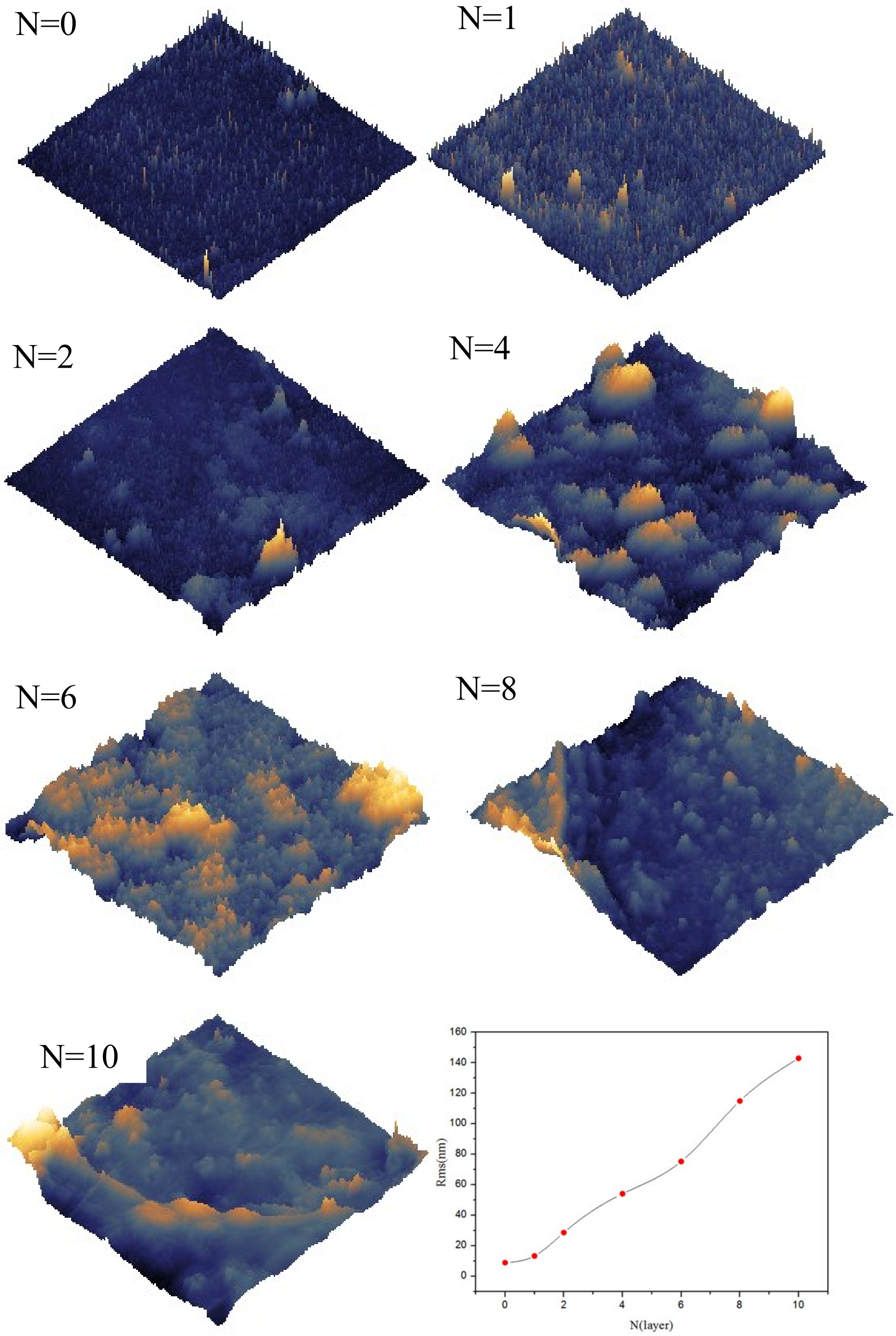

Fig.S1 Atomic force microscopy (AFM) topographic images of ribbon with N (=0,1,2,4,6,8,10)graphene

As the number of layers increases, the more the interface, the more the residual PMMA, and the superposition effect is more and more obvious. The root mean square roughness of the amorphous ribbons with graphene(N=0,1,2,4,6,8,10) is 9 nm, 13.4 nm, 28.7 nm, 54.2 nm, 75.3 nm, 115 nm, 143nm, respectively. Due to the gap between the interfaces, the rougher the interface is, and the roughness is relatively large.

2. GMI ratio dependence of field and frequency

The giant magneto-impedance effect is the result of the combined action of the DC magnetic field H_{ex}, the alternating magnetization drive field $\tilde{h}$, and the magnetic moment orientation inside the magnetic material. Since the amorphous ribbon has a transverse magnetic structure, when the external magnetic field H_{ex} increases along the longitudinal direction, the magnetization vector in the magnetic domain rotates toward the long axis direction, thus increasing the circumferential magnetic permeability, thereby increasing the impedance Z, and the magnetic permeability has the maximum value when the external magnetic field and the magnetic anisotropy field H_k are balanced. Continue to increase the external magnetic field, the magnetization process is occupied by the rotation of the magnetic moment, so that the magnetic permeability is reduced, and finally reaches saturation. If the applied magnetic field changes from $-H_{ex}$ to H_{ex}, the curve of the impedance with respect to the external magnetic field shows two peaks.

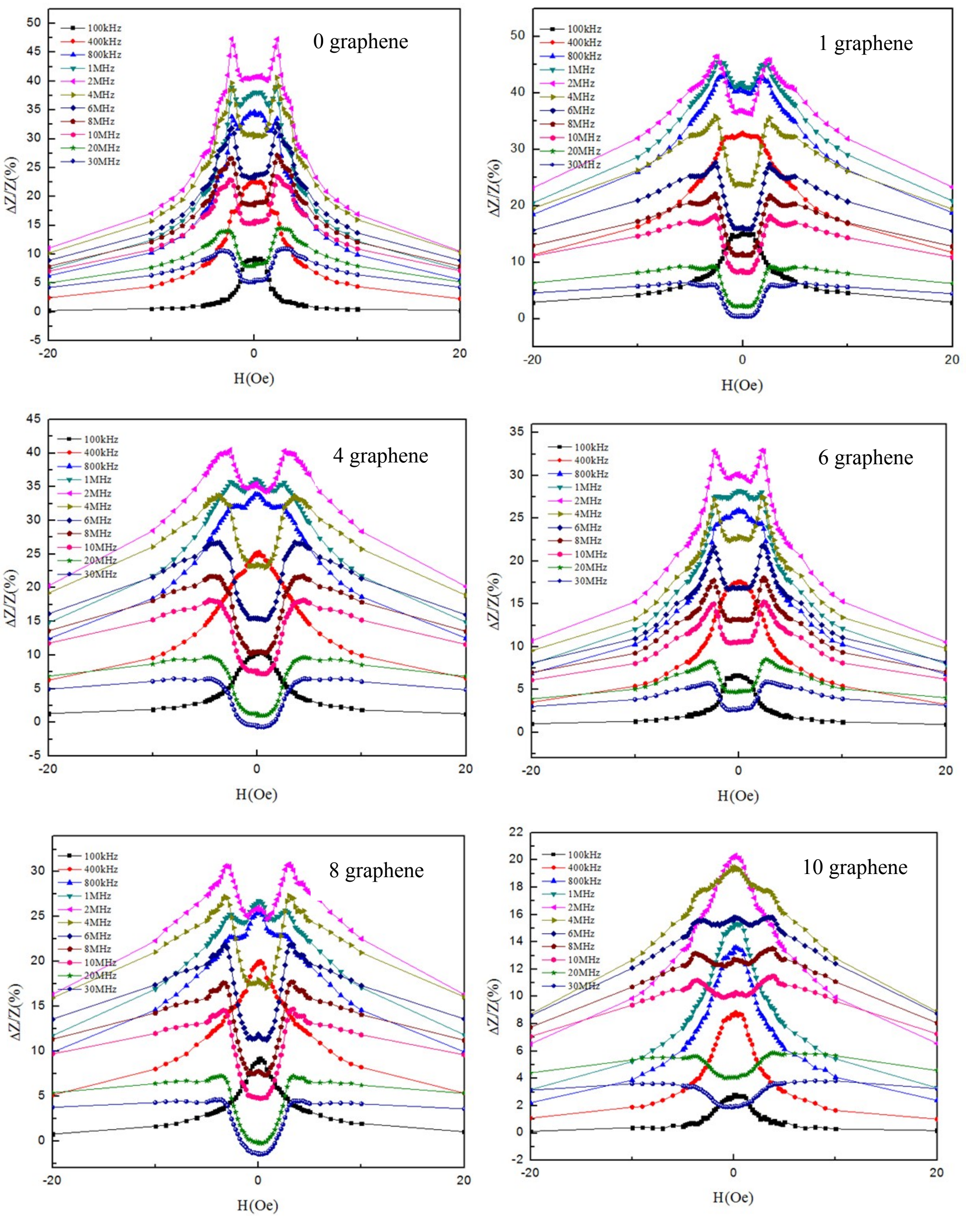

Fig.S2 GMI ratio in variation with the external magnetic field for different graphene of FINEMET at different frequency (100kHz ,400kHz,800kHz,1MHz,2MHz,4MHz,6MHz,8MHz,10MHz，20MHz,30MHz ,i=10mA)

It is noted in Fig.S2 that for the FINEMET/graphene composite ribbons have been investigated ,with increasing frequency, the maximum MI ratio first increased, reached a maximum at a particular frequency

$f_{\max}$ (often defined as a characteristic frequency).and then decreased for higher frequency. This trend can be interpreted by considering the relative contribution of domain motion and moment rotation to the transverse permeability and hence to the MI. At very low frequency, $[\Delta Z / Z]$ was relatively small due to the dominant contribution of the induced magneto inductive voltage to the measured magneto-impedance. In the middle range, the skin effect was dominant, hence a higher $[\Delta Z / Z]$ was observed. With the frequency increased, $[\Delta Z / Z]$ will decrease. This is because, in this frequency region, the domain wall displacement were strongly damped owing to eddy current .[1, 2]

3.the equation for the motion of the domain wall

The magnetic material is magnetized under alternating magnetic fields, and the equation for the motion of the domain wall can be expressed by classical formula [32].

$$m\frac{d^2x}{dt^2}+\beta\frac{dx}{dt}+ax=2\mu_0 M_s H(t) \qquad (3)$$

In the equation (3) , m represents the effective mass of the domain wall, and β represents the damping coefficient, a represents the elastic force response coefficient, x represents the distance of the domain wall displacement, $m\frac{d^2x}{dt^2}$ represents the inertia force of domain wall, and $\beta\frac{dx}{dt}$ represents the damping force of the domain wall movement, ax represents the resilience force of the domain wall back to the equilibrium position.

References:

[1]. Zhang, Q., et al., Giant magneto-impedance effect of magnetron sputtered $Ni_{80}Fe_{20}/SiO_2/Cu$ composite wires. Journal of Magnetism and Magnetic Materials, 2008. 320(19): p. 2319-2321.

[2]. Phan, M. and H. Peng, Giant magnetoimpedance materials: Fundamentals and applications. Progress in Materials Science, 2008. 53(2): p. 323-420.