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# Supporting materials

## Flexible electronic based on magnetic printing and volume additive principle

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**S1. Preparation of Fe nanoparticles**

Nanoscale iron particles were prepared as reported[1]. $FeCl_3 \cdot 6H_2O$(0.05M) was reduced by titration with $NaBH_4$(0.2M) in a vigorously stirred reaction flask. The iron nanoparticles precipitate was collected with vacuum filtration and washed with deionized water. Then nanoparticles were dispersed in alcohol and stored in nitrogen-purged atmosphere to minimize oxidation prior to research. The size and its distribution of iron nanoparticles was shown in Fig. S1. The even size of most of the iron nanoparticles is around 80 nm.

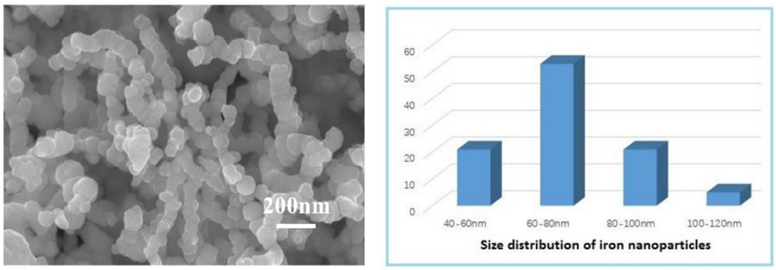


Fig. S1 The morphology of the iron nanoparticles and its statistic analysis of size distribution

**S2. Fabrication of magnetic field modulator**

Magnetic modulator with fringe pattern and the geometric dimension 6cm×3cm×1cm was made by arranging iron foils and aluminum foils interval and compressed by press machine in high pressure. The thickness of the foil is 300μm.

Magnetic modulator with curve pattern was fabricated by 3D printing based on stereolithography. A plastic plate with groove was 3D printed. Then the groove was fully filled with $Fe_3O_4$ particles. The nanoparticles on the surface of magnetic modulator were cleared up by scotch tape many times. The dimension of magnetic modulator is 2.5cm×2cm×0.5cm. The diagram of 3D printing based on stereolithography was shown in Fig.S2.

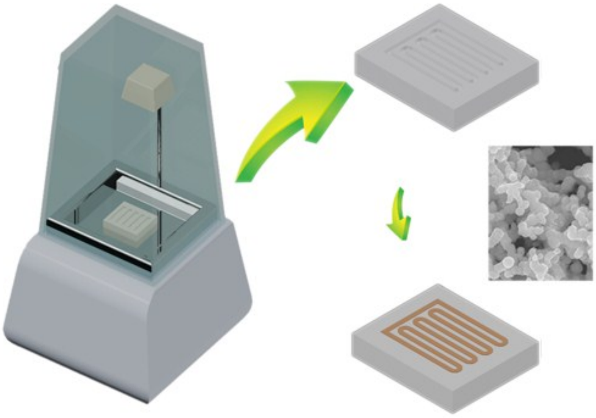

Fig. S2 Schematic diagram of preparing magnetic field modulator by 3D printing.

**S3. UV coating formula and its curing process**

The UV coating with 40wt% CN120 (epoxy acrylic resin), 20wt% TMPTA (trimethylolpropane triacrylate), 38wt% TPGDA (tri(propylene glycol) diacrylate), 2wt% photoinitiator 1173(2-hydroxy-2-methylpropiophenone) was mixed together. This coating was coated on the substrate by spreader with the thickness of 30 μm. Then, the substrate was irradiated 30 seconds by UV lamp with the light intensity of 30 mW/cm$^2$. Due to the oxygen inhibition, the surface of the coating was tacky which could adhesive the iron nanoparticles. After the iron nanoparticles were trapped on the substrate, the coating was irradiated second time and the coating was cured completely.

**S4. The calculation of $V_m/V_0$**

$$\frac{V_m}{V_0} = \frac{2\chi b^2 M_s H_0}{9\eta a V_0}$$

In this research, χ is the magnetic susceptibility of magnetic nanoparticles, χ=5000[2]; b is the radius of magnetic nanoparticles, b=80 nm; $M_s$ is the saturation magnetization of magnetic nanoparticles, $M_s$ =1700 mT[3]; $H_0$ is the intensity of external magnetic field, $H_0$=20mT; $\eta$ is the coefficient of kinematic viscosity of magnetofluid, $\eta$=1[4]; $a$ is the foil width of magnetic mold, $a$=300 μm. In addition, 1T=795774.71A·m$^{-1}$. Therefore,

$$\frac{V_m}{V_0} = \frac{2\chi b^2 M_s H_0}{9\eta a V_0} = \frac{2 \times 5000 \times (40 \times 10^{-9})^2 \times 1.7 \times 0.02 \times (79.6 \times 10^4)^2}{9 \times 300 \times 10^{-6} \times 1} = 127.6$$


**Reference**

1. A. A. H. John E. Martin, Weile Yan, Xiao-qin Li, Bruce E. Koel, Christopher J. Kiely, and Wei-xian Zhang, Langmuir: the ACS journal of surfaces and colloids, 2008, 24,, 4329-4334.

2. Lanzberg, Elementary physics,1955,

3. Zonghan Cheng, Hongjun He, Shihe Xu, Electroacoustic device materials and physical basis,2014

4. Guangqi Liu,Chemical property data sheet,2002