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Green Nano-blackboard

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Abstract

This design comprises two major materials, nano-Fe_3O_4 colloids and magnetic alloy Fe-Al-Mn. The nano-Fe_3O_4 colloids acted as photonic crystal are packaged by transparent PMMA sheets and the backside is alloy Fe-Al-Mn thin film. In addition to the board, the magnetic pen composed of both permanent and soft magnets could output tunable magnetic forces. And the eraser is a permanent magnet. The photonic band gap is changed by various magnetic forces of pen and then reflects specific wavelength to show corresponding color. To eliminate the handwriting, the eraser applies a reverse magnetic force to recover the nano-Fe_3O_4 colloid arrangement to original state. Besides, the design could combine with electrical devices to form a novel display performing superior features such as delicate and diverse colors, the highly energy-saving ability, low cost and long life span to other kinds of displays. Finally, the flexible substrate could substitute for PMMA to fabricate such unique electronic papers.

Introduction

Drastic deforestation still grows every year and leads to severe climate impacts. From Greenhouse effect to other disasters, the earth is suffering.

Materials

1. Nano-Fe_3O_4 Colloidal photonic crystal
2. Magnetic alloy Fe-Al-Mn

Principle

Nano-Fe_3O_4 colloid

The Nano-Fe_3O_4 is synthesized from $FeCl_3$ in diethylene glycol, DEG, by high-temperature hydrolysis. While reacting with poly(acrylic acid), PAA, as surfactant, Fe_3O_4 particles show high degree of dispersibility in water. And the size of Fe_3O_4 colloidal nanocrystal clusters could be controlled to have diverse optical properties. (Fig. 1)

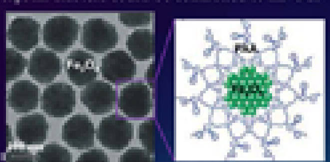


Fig. 1

Fig. 2

Superparamagnetic property

a. Mass magnetization as a function of applied external field

b. Different hysteresis loops of various sizes of Fe_3O_4 colloidal nanocrystal clusters (Fig. 2)

Photonic crystal-Fe_3O_4 colloid

The interspace of Fe_3O_4 colloidal nanocrystal clusters could be changed by different magnetic forces. For such a specific interspace, the photonic crystal, Fe_3O_4 colloidal solution shows a corresponding photonic band gap that controls the reflection spectra. With various applied external magnetic forces, the Fe_3O_4 colloidal solution performs wonderful and diverse colors. (Fig. 3, 4)

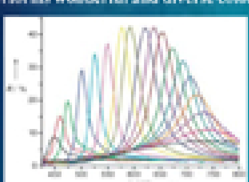


Fig. 3

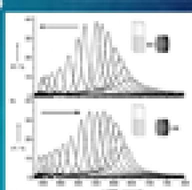


Fig. 4

Structure

Board

The Fe_3O_4 colloidal solution is packaged in poly(methyl methacrylate), PMMA, sheets. And the back side of sheets is deposited by magnetic alloy Fe-Al-Mn.

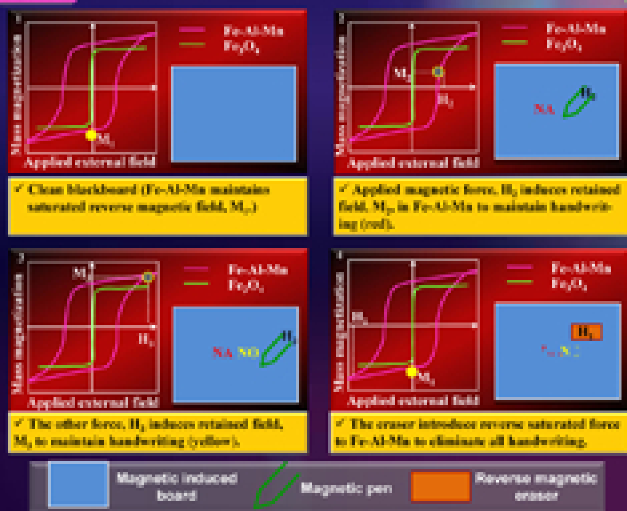
Magnetic pen

Eraser

The eraser is a permanent magnet performs reverse magnetic field compared to the pen.

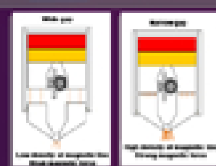
Operation

Board



Magnetic pen

The output of magnetic force controlled by tuning button induces various retained fields in Fe-Al-Mn film. The longer gap leads to lower density of magnetic line and makes weaker magnetic force output. And the shorter gap outputs stronger force.



Eraser

The strong reverse magnetic force of eraser induces reverse saturated field in Fe-Al-Mn film to recover original color (clear handwriting).

Comparsion and Future Prospect

Comparsion

	Traditional products	Novel boards
Image		
Material	Wood, alloy, paint	Ferromagnetic and superparamagnetic materials
Cost	High	Low
Life time (years)	3-5	Above 10
Risks for environment	High	--
Danger for health	High	--
Resolution	Limited	High
Consumables	Pens, erasers	--
Applications	--	Electronics

Future prospect

創意心得

奈米科技並非萬能，但結合適當材料與創意即可創造無限潛能，期待這股潛力可以在未來更加發光發熱，引領更美好世界的到來。