Designed Magnetic Multilayer Thin Films Fabricated via Layer-by-Layer Assembly of Polycyanofullerenes

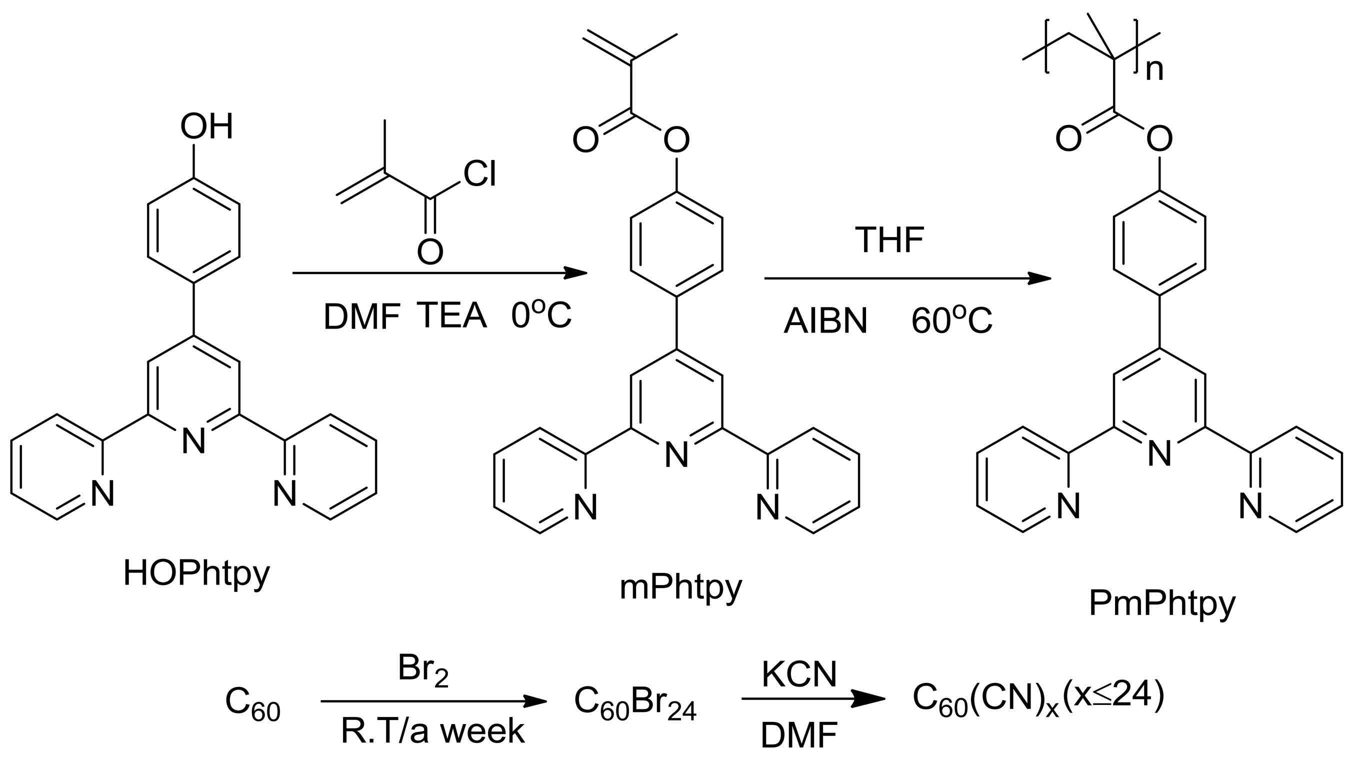
Jin Luo (11129027), Yanhua Wang, Rong Ren, Weilin Sun*

MOE Key Laboratory of Macromolecular Synthesis and Functionalization, Department of Polymer Science and Engineering, Zhejiang University, Hangzhou 310027, People's Republic of China

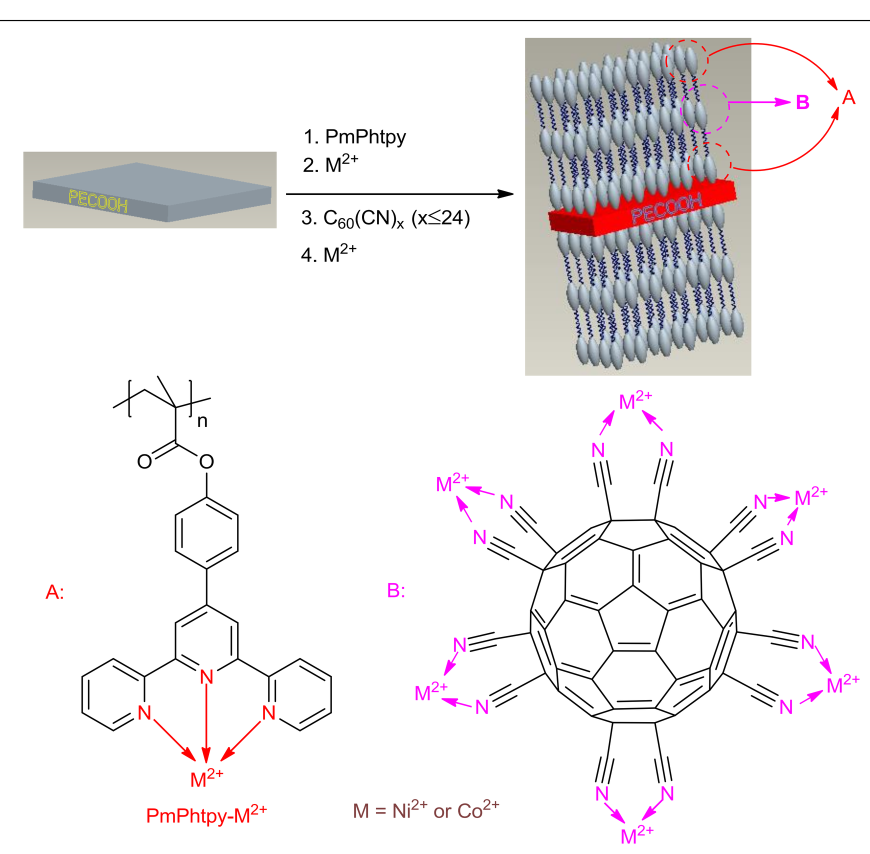
Introduction

Since the first report of uniform fullerene multilayer film prepared by layer-by-layer (LbL) assembly technique, some fullerenes-containing films have been fabricated,[1-2] but the magnetic properties of the fullerene-containing LbL multilayer thin film have seldom been reported. In this work, we fabricated three kinds of magnetic multilayer thin films with polycyanofullerenes containing cyan chelating groups, the polymer PmPhtpy containing terpyridine chelating groups and different transition metals (Ni^{2+} and Co^{2+}) via the LbL assembly process.

Experimental



Scheme 1. The synthetic route of the polymer and Polycyanofullerenes.



Scheme 2. Simplified Scheme of the Layer-by-Layer Self-Assembly Process for Fabrication of the Multilayer Film $(PmPhtpy/M^{2+}/C60(CN)_x/M^{2+})_{10\times4}$

Results and Discussion

1. Optical Characterization of the Films

Figure 1. Photograph (from left to right) of the HDPE film and the magnetic multilayer film $(PmPhtpy/Ni^{2+}/C_{60}(CN)_x/Ni^{2+})_{n\times4}$ (n = 6, 10).

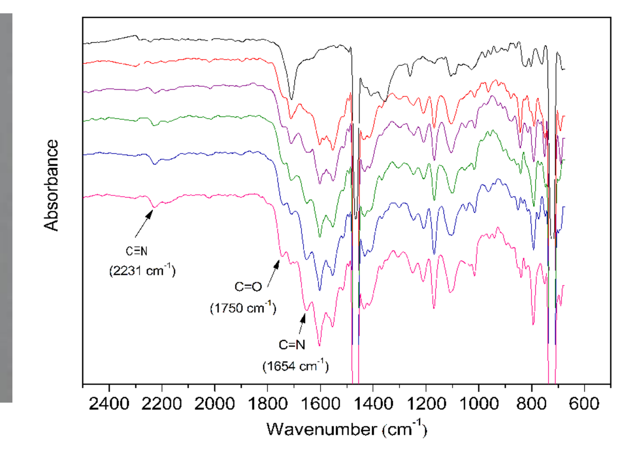


Figure 2. ATR-IR spectra of PE-COOH and the multilayer film $(PmPhtpy/Ni^{2+}/C_{60}(CN)_x/Ni^{2+})_{n\times4}$ (n = 2, 4, 6, 8, 10).

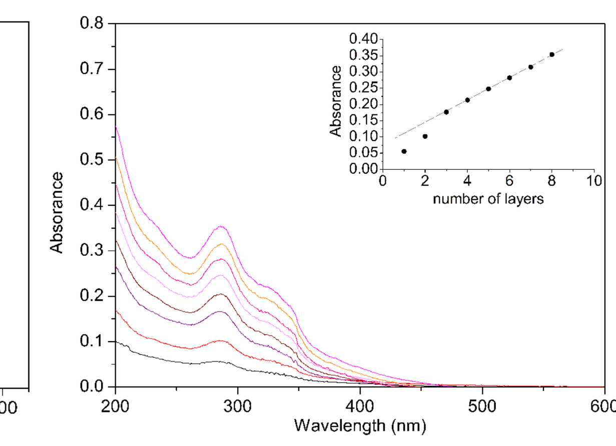


Figure 3. 1-8 layers of the multilayer film $PmPhtpy/Ni^{2+}/C_{60}(CN)_x/Ni^{2+}$. The inset shows the absorbance at 286 nm versus the number of layers.

2. Magnetic Properties of the Multilayer Films

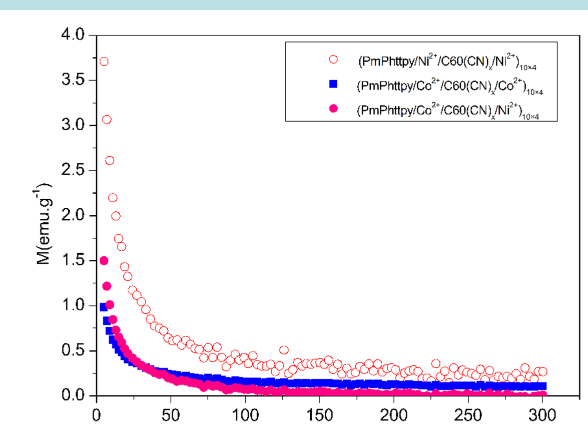


Figure 4. Temperature dependence of magnetization (M) for the films $(PmPhtpy/Ni^{2+}/C_{60}(CN)_x/Ni^{2+})_{10\times4}$,$(PmPhtpy/Co^{2+}/C_{60}(CN)_x/Co^{2+})_{10\times4}$ and $(PmPhtpy/Co^{2+}/C_{60}(CN)_x/Ni^{2+})_{10\times4}$ at H = 30 kOe.

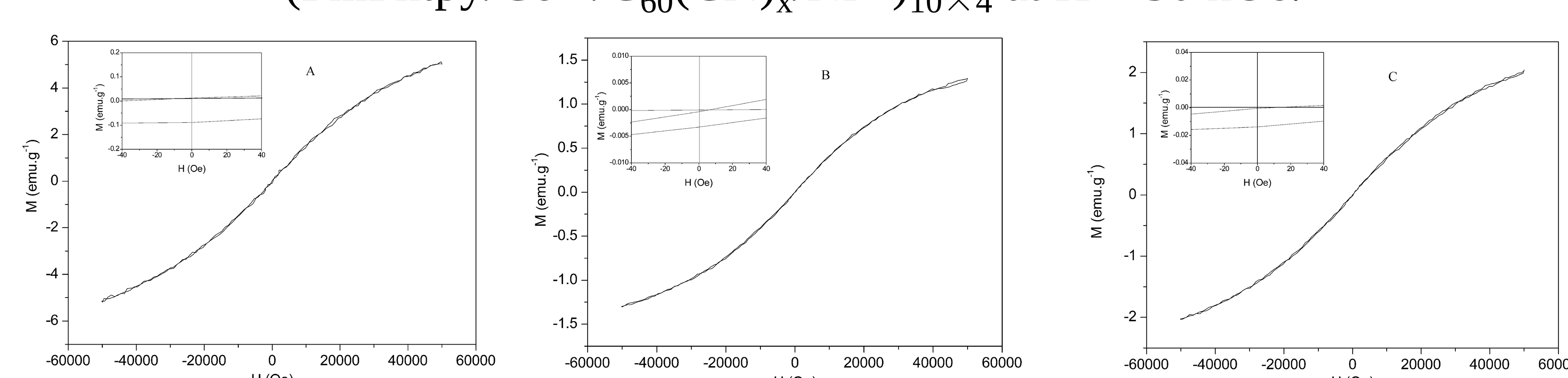


Figure 5. Hysteresis loop (M versus H) at 5 K for the multilayer thin film $(PmPhtpy/Ni^{2+}/C_{60}(CN)_x/Ni^{2+})_{10\times4}$ (A), $(PmPhtpy/Co^{2+}/C_{60}(CN)_x/Co^{2+})_{10\times4}$ (B) and $(PmPhtpy/Co^{2+}/C_{60}(CN)_x/Ni^{2+})_{10\times4}$ (C).

Conclusion

1. The optical properties of the films were measured by ATR-IR (Figure 2) and UV-vis (Figure 3) spectroscopy, and the results indicated that the driving force of fabricating the multilayer film was the coordination interaction.
2. The magnetic hysteresis loops of the films showed a typical "S" shape at 5 K(Figure 5), suggesting the soft ferromagnetic properties.
3. It is very promising for fabricating delicate magnetic devices under the sophisticated environment.

Acknowledgment

The authors acknowledge the financial support from National Natural Science Foundation of China (grants No. 21174129) and support by the Program for Zhejiang Leading Team of S&T Innovation (2011R50007).

References

1.Masuda, K.; Abe, T.; Benten, H.; Ohkita, H.; Ito. S. *Langmuir* **2010,** *26*, 13472.

2. Guldi, D. M.; Zilbermann, I.; Anderson, G.; Kotov, N. A.; Tagmatarchis, N.; Prato, M. *J. Mater. Chem.* **2005,** *15*,114.