Hydrothermal treatment effects on [6,6]-phenyl-C_{61}-butyric acid methyl ester

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1. Introduction

Formation of carbon nanostructures (fullerenes, nanotubes, nanofilaments, etc.) in gaseous media and/or vacuum has been widely studied. On the other hand, their formation from liquids or high-pressure, high-temperature fluids has received limited attention. Hydrothermal synthesis has become an important method for producing carbon materials. [6,6]-phenyl-C_{61}-butyric acid methyl ester (PCBM) is an electron acceptor material and is often used in plastic solar cells, and understanding the underlying physico-chemical processes occurring in the aqueous solution can be used for engineering hydrothermal crystallization processes. In this work, physical properties of hydrothermally-treated PCBM are studied and discussed.

2. Experiment

PCBM powder (purity 99%, SES research) was hydrothermally treated using proper aqueous solutions of ethanol (EtOH) as solvent in an autoclave at 180°C for a period of time (24-72 h). The solid PCBM products after washing and drying were characterized by superconducting quantum interference device (SQUID, Quantum Design) with a 7 T superconducting solenoid and X-ray photoelectron spectroscopy (XPS).

3. Results and discussion

Figure 1 shows the magnetization vs field (M-H) measurements at 5 K for the hydrothermally-treated PCBM samples, diamagnetic background depending linearly on the applied field being subtracted for the ferromagnetic hysteresis. The 5-day-treated PCBM sample shows quite a strong ferromagnetic ordering at 5 K.

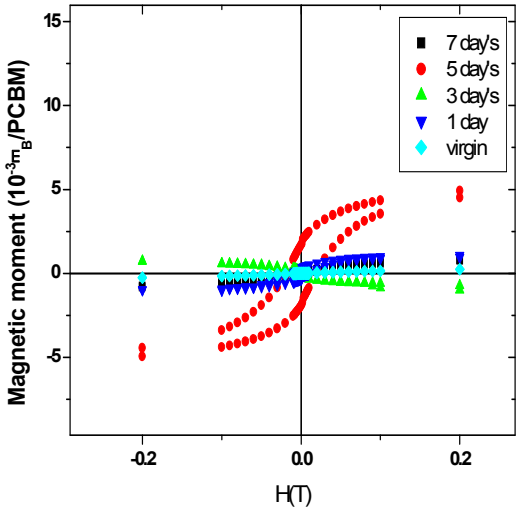

Fig. 1. Magnetization as a function of the applied magnetic field at T=5 K for sample PCBM.

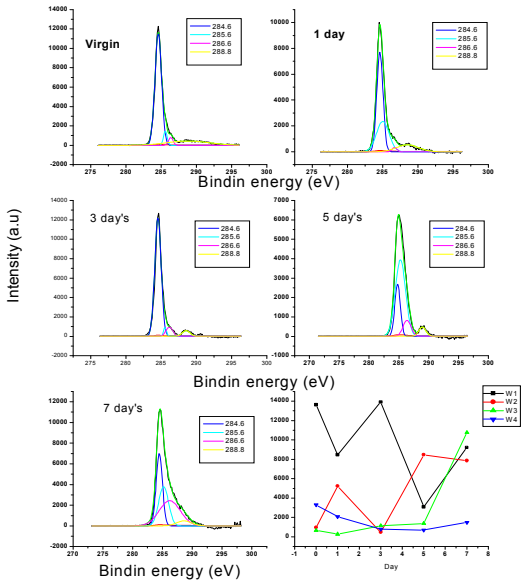

Fig. 2. C 1s XPS spectra of the PCBM samples.

Figure 2 shows the C 1s XPS spectra of the hydrothermally-treated PCBM samples. The core level spectra of carbon 1s for all the samples were fitted with four components positioned around 284.6, 285.6, 286.6, and 288.8 eV. The peaks at 284.6 and 285.6 eV correspond to sp^2 and sp^3 hybridized carbon atoms as in graphite, respectively. The other two peaks correspond to C-O bondings. Decrease in the sp^2 hybridization of the carbon atoms with hydrothermal treatment time was also observed.

4. Summary

We have carried out magnetic and spectroscopic studies on the physical properties of hydrothermally-treated PCBM samples. Strong ferromagnetic ordering was observed depending on the treatment time, and was studied in relation to the atomic bonding configurations.

5. References

[1] W. L. Suchanek, J. A. Libera, Y. Gogotsi, and M. Yoshimura, J. Solid State Chem. 160, 184 (2001).

[2] FU Yun-Chong, JIN Yun-Fan, YAO Cun-Feng, ZHANG Chong-Hong. Chinese Physics Letters Vol.26 No.1 016101 (2009).

[3] A. Kumar, F. Singh, D. K. Avasthi, and J. C. Pivin, Nucl. Instrum. Methods Phys. Res. B 244, 221 (2006).

[4] P. Esquinazi, A. Setwer, R. Hohne, and C. Semmelhack. Phys. Rev. B **66**. 024429 (2002).

[5] S. Talapatra, P. G. Ganesan, T. Kim, R. Vajtai, M. Huang, M. Shima, G. Ramanath, D. Srivastava, and P .M. Ajayan. Phys. Rev. Lett. **95**, 097201 (2005).