

## Facile synthesis of hollow Co submicrometer spheres

Jianchun Bao<sup>a,b,\*</sup>, Yongye Liang<sup>a</sup>, Yuying Feng<sup>b</sup>, Jie Zhang<sup>b</sup>, Zheng Xu<sup>a</sup>

<sup>a</sup>*State Key Laboratory of Coordination Chemistry, Laboratory of Solid State Microstructures, Nanjing University, Nanjing, 210093, P.R.China.*

<sup>b</sup>*Chemistry Department, Laboratory of Materials Science.*

---

Hollow cobalt submicrometer spheres have been prepared by controlling the redox reaction of  $\text{CoCl}_2$  with  $\text{NaBH}_4$  within the interface between the water and oil in cyclohexane/water/polyglycol emulsion system at  $60^\circ\text{C}$ . The diameter of the hollow cobalt spheres is mainly in the range of  $300\sim 400$  nm and the wall thickness is about  $70\pm 10$  nm. It is more interesting that the wall of the Co spheres is composed of rodlike particles with  $\sim 100$  nm in length,  $\sim 20$  nm in width. Furthermore, based on the high-resolution transmission electron microscopy (HRTEM) analysis, some of the rodlike particles are of tubular structure. It was also found that the components of the emulsion system and the reaction temperature have an important influence on the formation of the hollow cobalt spheres. i) The yield of the hollow Co spheres is variable with the volume ratio of the cyclohexane/water. For example, few hollow Co spheres could be seen at the 1:3 volume ratio of the water/cyclohexane while the yield of hollow Co spheres greatly increases at the 2:3 volume ratio of the water/cyclohexane under the transmission electron microscopy observation. ii) The formation of the hollow spheres strongly depends on the reaction temperature. For example, when the reaction temperature was raised to  $75$  from  $60^\circ\text{C}$ , the thread crystals were obtained instead of spheres. We thought that the reaction rate increases with the temperature raises, and when the reaction rate increase immensely, the redox reaction not only takes place on the interface between oil/water, but also easily and mainly occurs in bulk solution, as a result the function of the template is not obvious at the high temperature. When the PEG concentration raised from  $1.5\text{g polyglycol}/10\text{g H}_2\text{O}$  to  $3.0\text{g polyglycol}/10\text{g H}_2\text{O}$ , hollow Co spheres with smaller sizes ( $\sim 100\text{nm}$ ) were obtained, however, the mean size of the hollow spheres changed little. In addition, the reaction rate was slower when the polyglycol concentration raised, partially due to the increasing of the emulsion system viscosity. The magnetic properties of the hollow Co submicrometer spheres are also preliminarily studied. The typical coercivity is  $88$  Oe, which exhibits enhanced coercivity by comparison with that of the bulk Co (around  $10$  Oe for Co) [1]. The saturation magnetization of the hollow Co spheres are  $58\text{ emu}\cdot\text{g}^{-1}$

[1] S. Chikazumi, *Physics of Magnetism*, John Wiley & Sons, New York, 1964.

---

---

\* Corresponding author. Tel. 86-25-83598102.  
Email address: jcbao@jlonline.com ([Jianchun Bao](mailto:jcbao@jlonline.com)).