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Copper Induced Hollow Carbon Nanospheres by Arc Discharge: Synthesis and Mechanism

Shizuoka Univ. [1], CAS [2], ○ Rui Hu[1,2], Xiangke Wang[2] and Masaaki Nagatsu[1]

E-mail: huruimax@gmail.com

1. Introduction

Metal-induced nanomaterials encapsulated with graphitic carbon layer are one of the most extensively researched materials in the past twenty years, and have attracted considerable interest due to their strong potentials for catalysis, delivery system, nano-level storage, optical and electronic devices[1-2]. Therefore, the development of new carbon materials with novel morphologies and structures is still of significant importance in the material sciences. Recently, much work have been done on the fabrication of copper-carbon nanomaterials[3,4]. In this report, we synthesized copper initiated hollow carbon nanospheres by a direct current arc discharge method.

2. Experimental Procedures

The copper induced hollow carbon nanospheres were prepared using direct current arc discharge device (as shown in Figure 1).

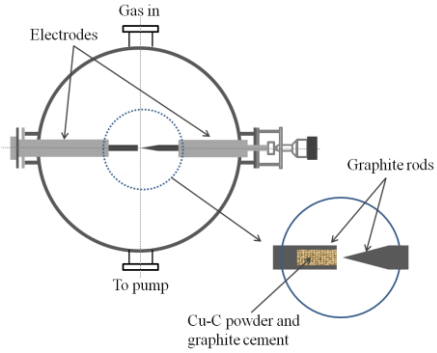

Figure 1. Schematic draw of arc discharge device

Two graphite rods have been placed inside the stainless-steel vacuum chamber with diameter of 200 mm. The anode was molded with copper powder and graphibond-551R, and the cathode was a pointed graphite rod (50 mm×Ø10 mm, purity 99.9%). Then all system has been evacuated to several Pa by a rotary pump. A mixture gas of He:CH_4 with ratio 8:2 was flown to the chamber until the pressure reached 1.3×10^4 Pa. The arc discharge was generated by applying a high current of ~120 A at ~20 V between the two electrodes.

3. Results and Discussion

Hollow carbon nanospheres with some cracks on the surfaces were observed (as shown in Figure 2), and their morphologies in different stages were analyzed by using the scanning transmission electron microscope (STEM). Considering the specific physical properties of the copper core and graphitic shells (i.e., carbon solubility, thermal expansion coefficient and vapor pressure), we proposed possible formation mechanisms of the specific carbonaceous nanostructure by the comparison of different kinds of metal-carbon nanostructures prepared by the arc discharge method for silver-carbon, gold-carbon, zinc-carbon and tin-carbon. The hypothesis of escaping copper cores as templates from the broken graphitic shells was made reasonably.

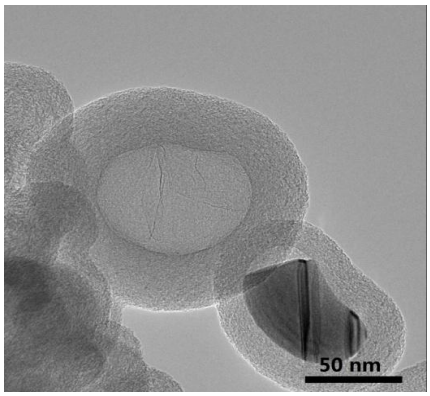

Figure 2. Typical morphology of hollow carbon nanospheres.

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