MICROSCOPIC STUDY OF THE MACROSCOPIC CARBON TREES

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INTRODUCTION

Carbon is a fantastic element from which a various of materials can be produced. Besides the traditional, macroscopic materials such as activated carbon, carbon black and graphite that all have been used industrially, nanocarbon becomes, since the discovery of fullerene and carbon nanotube, a main focus point for material scientists, physicists and chemists. Nowadays, carbon nanotube, nanobelt, nanohorn, nanobulb, nanoball, nanocore and nanotree have been synthesized and characterised widespreadly. All these forms of carbon have been considered to exist in microscopic scale. Recently, it is shown that carbon trees can be synthesized at macroscopic scale by chemical vapour deposition (CVD) of toluene [1]. Nanostructured carbon produced in macrosocopic scale could be of importance since it combines the property of nano-size effects with the advantage of easier handling and manipulations. On the molecular level it is potentially useful to grow dendritic structures of nanocarbon onto each other to maximise the surface area and to provide molecular roughness for entanglement of, for instance, polymer strands. We present in this work the microscopic study of the macroscopic carbon tree.

EXPERIMENTAL

The experiments were carried out in a floating catalytic CVD system, which included a horizontal tubular quartz reactor and corresponding heating installation. Toluene is used as carbon feedstock and ferrocene as catalyst. The products grow under atmospheric pressure when toluene vapor is introduced into the 1000°C - 1150 ^{o}C quartz reactor by bubbling an Ar flow of 150 ml min^{-1} through toluene at room temperature. At the same time, another Ar flow of 600-3000 ml min^{-1} was used as carrier gas for catalyst. The thermocouple coated with alumina tube was placed directly in the heating zone in order to control and test the pyrolysis temperature precisely. 100 mg of ferrocene powder was placed into the low temperature zone at gas inlet part, ferrocene was vaporized at 120-140 ^{o}C and carried by the argon flow into the quartz reactor. After a duration about 30 minutes, the tree-like samples can be collected from the thermocouple end.

RESULTS AND DISCUSSION

Figure 1 show an overview of several freestanding carbon trees with height from 1 to 7 centimeters and diameters from 2 to 8 millimeter, respectively. The most prominent feature of the trees is the dendritic structure, which is evidently different from the reported carbon tree of cedar form or from carbon microfibre. This is clearly revealed in the figure 2a and 2b exhibiting the multi-branched structure of the trees. The branch consists of carbon particles. The SE images and BSE images in figure 2c and 2d indicate

that Fe particles produced from ferrocene are encapsulated in the branches of the carbon tree. High-resolution TEM images reveal the graphitic structure of the branches. The detailed microstructure and growth mechanism of the carbon tree will be presented at the conference.