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DCアーク放電を用いた炭素被覆混合金属ナノ微粒子の作製

Fabrication of carbon-encapsulated multi-metallic nanoparticles by DC arc discharge

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1. Introduction

It is known that gold nanoparticles interact with light and occur Surface Plasmon Resonance (SPR). SPR indicate the nature that different wavelengths of light absorbed by the size and shape of gold nanoparticles, so gold nanoparticles are applied in various fields such as engineering, chemistry and medicine. It is common that diffusing gold nanoparticles in the liquid are recovered by centrifugal filtration. If gold nanoparticles have magnetism, we can collect them easily by magnet. In this study, we tried to make carbon-encapsulated Au-Fe nanoparticles by DC arc discharge. The study of graphite-encapsulated gold nanoparticles fabricated by DC arc discharge is already reported in the previous study (Enbo, et al, JJAP 2014). This study was carried out in reference to that previous study.

2. Experimental setup

DC arc discharge device contains a chamber, two electrodes, direct power supply system, pumping vacuum system and the water cooling system (Fig.1). First, we drilled a hole in the center of the carbon rod and put materials in there. We used Fe_2O_3 powder, Au powder, graphite powder and Graphi Bond as glue. The ratio of materials reported in the previous study is described below.

Carbon: Au: Graphite bond=1:1:2

The “Au” in this parameter was replaced by “Au + Fe_2O_3” in this study. The ratio of Au and Fe_2O_3 was varied as 1:9, 5:5 and 9:1, which were named sample1, sample2 and sample3, respectively. The filled rods were heated at 120 ºC for 12 hours. After evacuating the discharge chamber, He and CH_4 gas in a ratio 4:1 was introduced. Discharging time was less than 1 min and nanoparticles deposited on the top of chamber were collected.

3. Result

First, we confirmed whether nanoparticles have magnetism. Nanoparticles in ethanol were sufficiently diffused and closer to the magnet. Sample1 and sample2 were attracted to the magnet but sample3 was not.

Then, we observed them by TEM. Before observation, the fully diluted nanoparticles were separated by an ultrasonic cleaner. The TEM image is shown in Fig.2. It contains several tens nm particles of Au and Fe into carbon particles of about 50 nm. It was found that the distribution of Au and Fe in smaple3 overlap by EDS composition mapping. The detail of experiments will be presented at the meeting.

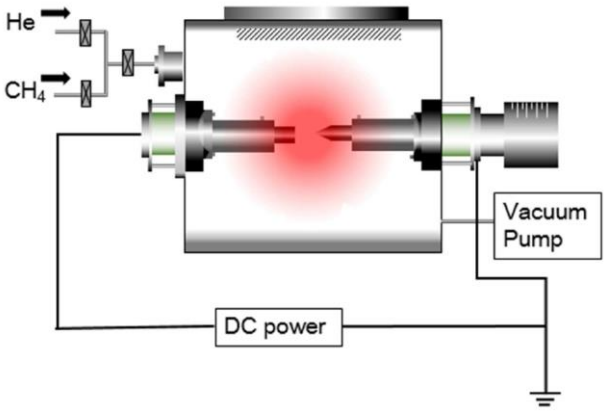

Fig.1. Schematic view of the arc discharge device used in this work

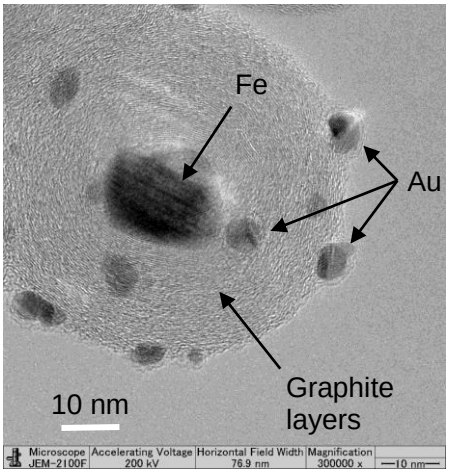

Fig.2. TEM image of sample1