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グラファイト外包磁気ナノ微粒子の表面化学修飾における RFプラズマ中への微粒子導入の効果
Effect of Particle Injection into RF Plasma on Surface Functionalization of Graphite-encapsulated Magnetic Nanoparticles

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1. Introduction

Because of the excellent superparamagnetic property of the graphite-encapsulated magnetic nanoparticles (GEMNPs), they could be easily controlled by magnetic force. Recently, many bio-applications with magnetic nanoparticles, such as drug delivery system (DDS) used to deliver the medicine into the body and bio-sensor to detect the biological material, have been extensively researched. To utiliza the GEMNPs to bio-application, it is required to immobilize biomolecules to surface of nanparticles. If GEMNPs are modified by functional groups (carboxyl group, amino group, etc.), we can make it easy to immobilize biomolecules selectively. There are many methods to surface modifications, such as wet chemical process, heating, or plasma. Among them, plasma technique is more preferable to use because it provides us a dry process at low temperature.

2. Experimental setup

The GEMNPs were made by arc discharge method. Iron particle as core metal are encapsulated by several graphere layers. We treated GEMNPs with an inductively coupled radio frequency plasma device shown in Fig.1.

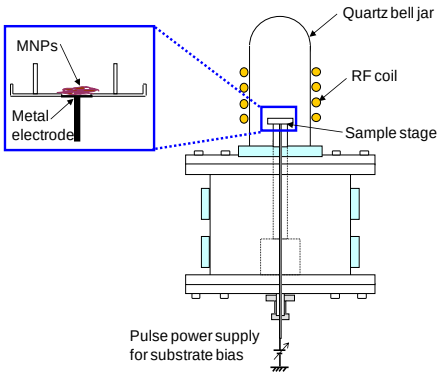

Fig.1 RF driven inductively coupled plasma device

To introduce amino group on surface of the particles, NH_3 plasma was used. Sample was put on electrode plate, during the discharge negatively biased by a high voltage pulse power was supplied. We investigated the effect of negative bias on the surface modification of the particles.

3. Result

We analyzed the number of amino group on surface of treated GEMNPs using chemical method. The result is shown in Fig.2. We changed the number of powder explosion from 0 to 3 times. We can found that the number of amino group on surface of GEMNPs was about 2~3 times increased by negative biasing explosion, compared to the results without bias. By introducing the particle into the plasma, the particles interacted with plasma more and more, so the number of amino particle increased. And, when the numbers of powder expolosion are over 3 times, the number of amino group saturated as shown in Fig. 2.

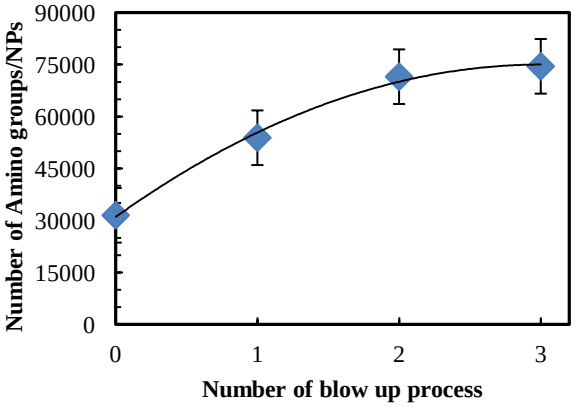

Fig. 2 Number of particle explosion versus the number of amino groups on each particle surface.

3. Conclusion

We have carried out surface modification of GEMNPs using negative bias technique. It is concluded that the surface functionalization of amino group can be enhanced by the powder explosion. More detail of result will be presented at the meeting.