

Ar/H₂O RF プラズマを用いたグラファイト被覆磁気ナノ微粒子
のカルボキシル基表面修飾とその定量的評価

Surface Functionalization of Carboxyl Groups onto Graphite-encapsulated Magnetic Nanoparticles by Ar/H₂O RF plasma and Quantitative Evaluation

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1. Introduction

In recent years, research on bio-medical applications that take advantage of the characteristics of the magnetic nanoparticles has been developed. In particular, graphite-encapsulated magnetic nanoparticles (GEMNPs) are coated with graphite. From advantages that they are stable in strong acid because graphite prevent core metal such as Fe from oxidation, they could be easily control by magnetic, the applications to various medical biotechnology are expected. In our group, we have been successfully carried out magnetic recovery of viruses and bacteria using magnetic nanoparticles functionalized by plasma surface modification.

In this study, we aim to establish a high-sensitivity bacterial detection method based on the carboxyl group modification of GEMNPs. A quantitative evaluation of the number of carboxyl groups that have been introduced onto the surface of magnetic nanoparticles was carried out using the toluidine blue O (TBO) assay.

2. Experimental details

We used an inductively-coupled radio frequency plasma device for surface functionalization of carboxyl groups onto GEMNPs prepared by the DC arc discharge device. Using this plasma device, we could respectively functionalize with carboxyl groups (Ar/H₂O plasma) and amine groups (Ar/NH₃ plasma) for GEMNPs.

GEMNPs were functionalized by the two-step processes: pre-treatment for 2 min with only Ar plasma and post-treatment 1 min in a mixture of Ar/H₂O with an input RF power of 80 W. Here, H₂O mixture ratio was varied in the post-treatment. Furthermore, the analysis of the number of carboxyl groups was performed using TBO assay as shown in Fig.1.

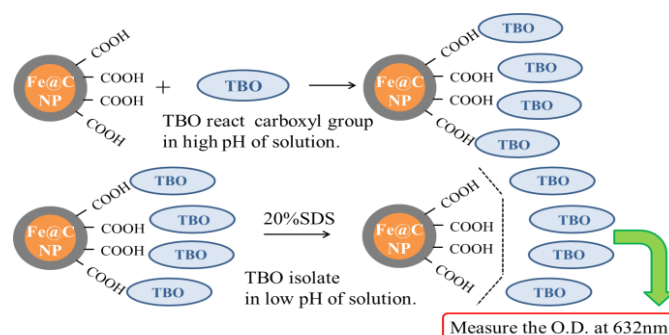


Fig.1:TBO assay for carboxyl groups analysis

3. Result

The experimental result is shown in Fig.2. In this experiment, it was carried out the gas addition rate of H₂O was varied between 0 and 20 %. From Fig.2, when the addition rate of H₂O was 2%, it was confirmed that number of carboxyl groups/NP is maximized. And increasing the H₂O addition rate, the number of carboxyl groups/NP have decreased. According to the previous OES experiment, it is considered that OH radicals were maximized at 2 % of H₂O gas addition.

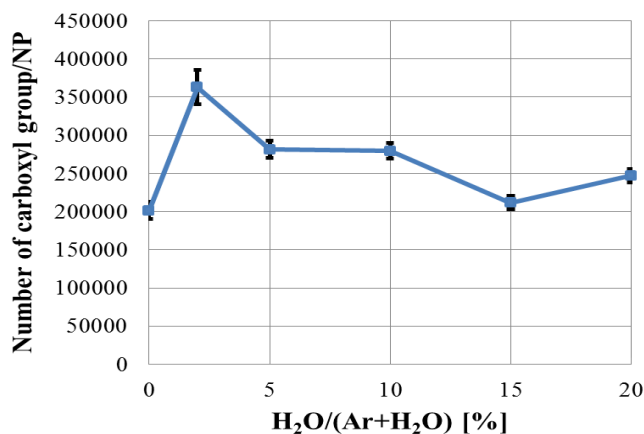


Fig.2: Numbers of carboxyl groups/NP versus gas mixture rate of H₂O in the post treatment