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# 四重極質量分析器を用いたアミノ基表面修飾用表面波 Ar/$NH_3$ プラズマの質量スペクトル計測

# Optical Spectroscopy and Mass Spectrometry Measurements during Amino-group Surface Modification of Nanoparticles Using Surface-wave Excited Ar/$NH_3$ Plasma

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## 1. Introduction

Recently, due to their remarkable properties like oxidation resistance and high hydrophilicity, graphite encapsulated magnetic nanoparticles (GEMNPs) are a strong candidate to be implemented in novel drug delivery or virus detection systems. To improve the efficiency of this nanoparticles we propose a novel, fast and reliable functionalization method represented by low temperature plasma processing as an alternative to the traditional wet chemical methods. In the current work we study the mechanism of plasma processing by employing quadrupole mass spectrometry correlated with optical emission spectroscopy.

## 2. Experimental setup

In figure 1 the schematic representation of the plasma processing unit is shown. Surface wave plasma (SWP) is ignited in different mixtures of Ar and $NH_3$ by launching the microwaves through slot antennas in the stainless steel vacuum chamber.

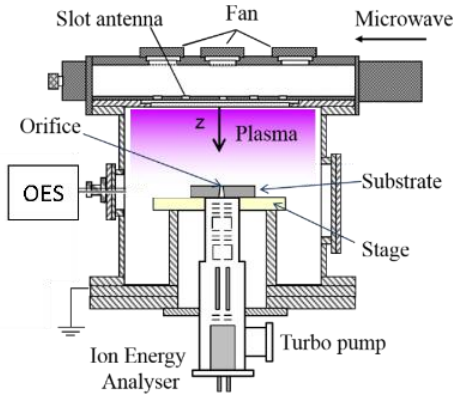


Fig.1 Schematic drawing of SWP device [1]

## 3. Results and discussions

In our study, we use a mixture of Ar and $NH_3$ gases to investigate the optimum efficiency of the plasma processing technique toward the amination of the GEMNPs. Previously we showed that the creation of NH radicals plays and important role for the amine group introduction. Therefore, in Figure 2 (a and b) the comparative plotting of the intensities of the emission lines of NH (336nm) and Ar (696.5nm) for different mixtures of $NH_3$ and Ar are shown. The highest intensity for NH and Ar lines seems to be when only 10% $NH_3$ is used in the gas mixture.

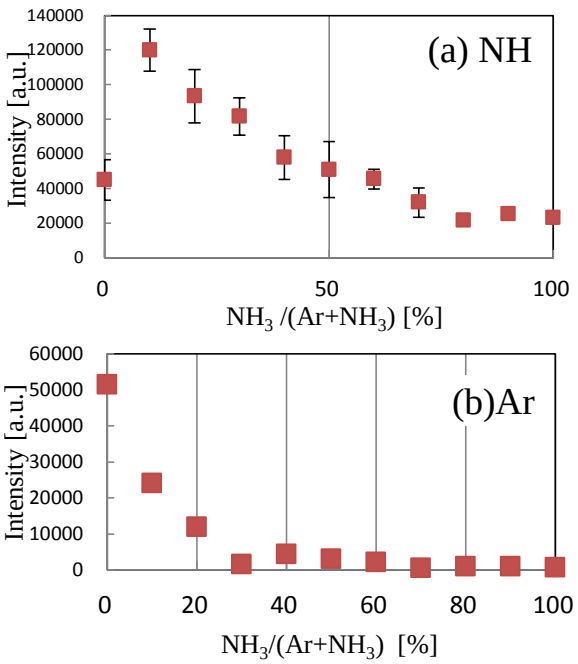


Fig.2 Emission intensity of $NH_3$ /Ar plasma. (*a*) NH (336nm); (*b*) Ar (696.5nm)

To prevent the dissociation of the $NH_3$ by the QMS the ionization energy was reduced until 18eV to assure that we are measuring only the neutrals from the plasma. Detailed information will be provided during the conference.

Reference

[1] Raman Bekarevich et al, J. Phys. D: Appl. Phys. 48, 045202, 2015