

論文 / 著書情報
Article / Book Information

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Title(English)	Study on Fabrication of YVO4:Eu3+ Nanoparticles by Laser Ablation in Liquid
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種別(和文)	論文要旨
Type(English)	Summary

論文要旨

THESIS SUMMARY

専攻 : Department of	物質科学創造	専攻	申請学位 (専攻分野) : Academic Degree Requested	博士 Doctor of	(Engineering)
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要旨 (英文 800 語程度)

Thesis Summary (approx.800 English Words)

Chapter 1. General Introduction

In this chapter, the background of laser ablation in liquid (LAL) will be described; the traditional synthesis methods and applications of lanthanide (Ln)-doped luminescence materials will be introduced. LAL has attracted considerable interests as an innovative technique to prepare various colloidal nanoparticles since the pioneered works in the early 1990s by Fojtik and co-workers. When the surface of the target material is irradiated by a laser beam with high fluence, a plasma plume containing atoms, ions, clusters will be created, and rapidly quenched by confinement of liquid phase. Nanoparticles with sizes much smaller than the target materials are collected in the liquid. Ln-doped oxide nanoparticles have aroused great attention because of their interesting electrical, chemical and optical properties. YVO_4 is one of the most classical matrices for Ln doping, which is known as a useful probe for biological applications. In conjunction with different dopant ions, it is possible to obtain multicolor emission via excitation with ultraviolet (UV) light, and highly efficient up-conversion emission is possible via near-infrared (NIR) excitation.

The objectives of this study are, firstly, to synthesize the $YVO_4:Eu^{3+}$ nanoparticles by LAL; secondly, to explore effect of liquid properties on nanoparticles formation; finally, to study the dynamics of cavitation bubble induced by LAL for better understanding of particle growth.

Chapter 2. Effect of Water Based Solution on $YVO_4:Eu^{3+}$ Nanoparticles Formation by Laser Ablation in Liquid

In this chapter, $YVO_4:Eu^{3+}$ nanoparticles were synthesized in DI water and surfactant solution. The experimental process appears to be very simple: a piece of $YVO_4:Eu^{3+}$ pellet obtained by pressing commercial powders is immersed at the bottom of a container covered with the liquid media, and the laser beam is focused on its surface. The effect of laser fluence were discussed in detail. After the laser ablation, the morphology showed the ovoid-like shape, this phenomenon was never reported. In order to obtain the nanoparticles with smaller size, the surfactant was used. The similar experimental set-up was used. Only the DI water was replaced by surfactant solution. Sodium dodecyl sulfate (SDS) was found to be one of the most efficient among the surfactants to reduce the mean size of metal nanoparticles by physically or chemically interacting with the surfaces of the forming particles during the LAL. This is also the first time to investigate the effect of SDS to synthesize $YVO_4:Eu^{3+}$ nanoparticles by LAL. The SEM and TEM results showed that the median particle size decreased clearly from 97 nm to around 50 nm by using SDS. And the morphology also changed from ovoid shape (in DI water) to nearly sphere shape.

Chapter 3. Effect of Ethanol on $\text{YVO}_4:\text{Eu}^{3+}$ Nanoparticles Formation by Laser Ablation in Liquid

In this chapter, the effect of ethanol on nanoparticles formation was studied. The liquid properties such as refractive index, viscosity, polarity index, are important factors to influence the particle formation by LAL. The SEM results showed that as-obtained nanoparticles had sphere shape, which was totally different from as-obtained in DI water, which might be caused by the modification on the particle surface by the ethanol molecules. However, parts of the spherical nanoparticles were amorphous phase that proved by HR-TME characterization. The particle size distribution and optical properties were also analyzed.

Chapter 4. Effect of Sequential Laser Irradiation on $\text{YVO}_4:\text{Eu}^{3+}$ Nanoparticles Formation by Laser Ablation in liquid

In this chapter, a free liquid reactor was utilized to synthesize $\text{YVO}_4:\text{Eu}^{3+}$ nanoparticles to study the effect of laser ablation to $\text{YVO}_4:\text{Eu}^{3+}$ nanoparticles. The fabricated nanoparticles had ovoid or spindle shape depending on the number of laser irradiation cycles. HR-TME results showed that spindle-like particles were single-crystalline with high crystallinity, which is beneficial for high luminescence efficiency. Strong light emission even from a single particle was confirmed by cathodoluminescence mapping. A possible mechanism of nanoparticle formation was proposed and discussed.

Chapter 5. Dynamics of Cavitation Bubble in Nanoparticles Formation Induced by Laser Ablation in Liquid

The cavitation bubble generated during laser ablation in liquid is considered to be an important factor for nanoparticles fabrication. It is therefore quite necessary to observe the bubble dynamics throughout the entire process to better understand the role in nanoparticles growth. In this chapter, the imaging approach was utilized to conduct the real-space, time-resolved observation of YVO_4 nanoparticles generation by laser ablation in liquid. The pressure inside the cavitation bubble was estimated more than 100 bar using Rayleigh-Plesset equation, and the temperature could reach up to 1000 K using isentropic relation.

備考：論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

Note: Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1 copy of 800 Words (English).

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