気液スラグ流非熱プラズマ反応器による酸化セリウムナノ粒子の合成

Synthesis of Cerium Oxide Nanoparticles by Non-thermal Plasma in slug flow reactor system

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Introduction

Atmospheric pressure non-thermal plasma has attracted much attention because of their various application, such as organic compounds decomposition, and synthesis of nanoparticles. Cerium oxide nanoparticles (CeO-NPs) have been used in various engineering and biological applications, such as catalysts, sensors, UV filter, and thermal agent. In this work, non-thermal plasma in a slug flow capillary reactor system is used to synthesize CeO-NPs. In the slug flow tube, the shape and size of the gas are uniform. Circulating flow in the liquid phase accelerates the uniform reaction. Since small bubbles do not grow into large bubbles, it is possible to maintain an interface with a high specific surface area. Due to these advantages, this system provides a very uniform plasma reaction field and is effective for the synthesis of highly uniform products.

Materials and Methods

The gas-liquid slug flow was generated in a capillary glass tube by flowing Ar gas and feed solution alternately. The mixed aqueous solution of 6 mmol/l cerium nitrate and 0.1 wt% starch was used as the feed. Through the copper plate attached to the outer surface of the glass capillary tube, an AC 10 kV voltage was transferred into the Ar gas phase to generate plasma in the glass capillary tube. The generated CeO-NPs were characterized by transmission electron microscopy (TEM) equipped with energy dispersive X-Ray spectroscopy (EDX).

Results

Fig.1 shows the EDX spectrum of CeO-NPs products without stabilizer, as metallic Ce and O were detected, the size of nanoparticle was around 4 μm. Fig.2 shows the TEM images and particle size distributions of the CeO-NPs products with starch stabilizer. With starch as stabilizer, the size of CeO-NPs was more uniform and the average size was around 3 nm, which shows stabilizer combined with “Pulsed Discharge Plasma in a Slug Flow Reactor System” could prevent CeO-NPs aggregate.

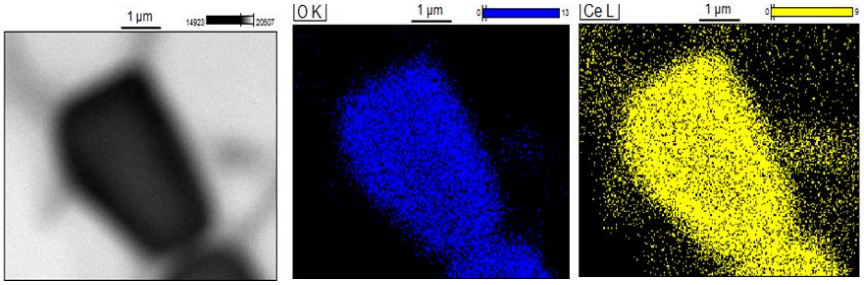

Fig.1 EDX spectrum of CeO-NPs products from the slug flow reactor system without stabilizer

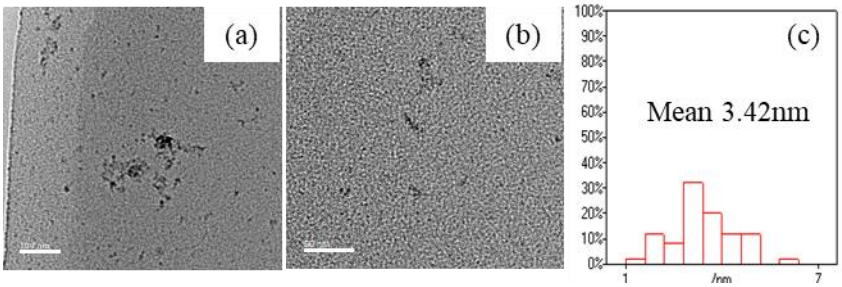

Fig.2 (a), (b) TEM images; (c) particle size distributions of CeO-NPs products from the slug flow reactor system with starch stabilizer