論文 / 著書情報
Article / Book Information

題目(和文)	核生成界面を制御する溶液プロセス －異方成長CeO $_2$ ナノワイヤー、CeO $_2$ 膜およびZnO膜の作製－
Title(English)	Solution-based Process Controlling Nucleation Interfacial Behavior —Fabrication of Anisotropic CeO $_2$ Nanowires, CeO $_2$ Films and ZnO Films—
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
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論 文 要 旨

THESIS SUMMARY

系・コース： Department of, Graduate major in	材料 系 材料 コース	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of （ 工学 ）
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

This thesis, titled as ***"Solution-based Process Controlling Nucleation Interfacial Behavior —Fabrication of Anisotropic CeO_2 Nanowires, CeO_2 Films and ZnO Films—"***, was composed of 6 chapters and written in English. CeO_2 nanowires/nanorods, CeO_2 films and ZnO films were fabricated without any additives and their seed layers at process temperature of 60 °C by the newly developed solution-based processes, named as gas-liquid precipitation and gas-assisted liquid phase deposition (G-LPD). The formation mechanisms of the anisotropic growth of CeO_2 nanowires/nanorods and CeO_2 and ZnO films were also proposed in the thesis.

In ***Chapter 1 "Background and Objective of This Study"***, the general conventional synthesis processes of oxide nanoparticles and films were introduced, and the issues of these processes were defined in terms of purity of products and simplicity, temperature and deposition area of the processes. This chapter also described the basic properties and applications of CeO_2 and ZnO, and the methods of characterization of the fabricated CeO_2 nanowires/nanorods, CeO_2 films and ZnO films. The main focuses of the thesis were as follows;

(1) To fabricate CeO_2 anisotropic nanoparticles without any additives by the gas-liquid precipitation process.
(2) To propose formation mechanism of CeO_2 nanowires and nanorods by the gas-liquid precipitation process.
(3) To fabricate crystalline CeO_2 films without their seed layers by the G-LPD process using readily available metal salts.
(4) To fabricate crystalline ZnO films without their seed layers by the modified G-LPD process, and expand the applicable range of the G-LPD process.

The developed solution-based processes, the gas-liquid precipitation process and the G-LPD process, were explained in detail in ***Chapter 2 "Novel Solution-based Processes"***. The unique point and aims of these processes were usage of gaseous NH_3 generated from aqueous solution of NH_3 or compounds, which generated NH_3 by hydrolysis, and heterogeneous nucleation at a gas-liquid interface or a solid-liquid interface. In the gas-liquid precipitation process, the gaseous NH_3, which was introduced to an aqueous metal salt solution, induced oxide precipitation at the gas-liquid interface. The interface played a role as a soft template to fabricate anisotropic nanoparticles. In the G-LPD process, a small amount of generated and introduced gaseous NH_3 controls the pH of the metal salt solution in a preferable pH range for the direct oxide formation. The detail explanation and calculation of the preferable pH range were described in this chapter.

Chapter 3 "CeO_2 Nanowires and Nanorods Fabrication by Gas-liquid Precipitation Process" showed that CeO_2 nanowires with lengths of 6 μm and diameters of tens of nanometers, and nanorods with lengths of several micrometers and diameters of from tens to hundreds of nanometers were fabricated at a low process temperature of 60 °C without any additives by the gas-liquid precipitation. In this process, aqueous solutions of $Ce(NO_3)_3$ and $CeCl_3$ were used as a starting material and aqueous NH_3 solution was used to generate gaseous NH_3. The generated gas induced CeO_2 precipitation at the gas-liquid interface. According to TEM observation, CeO_2 mesocrystals, which formed in an initial step of this process, grew in a direction of <011> into nanowires and nanorods exposing {011} and {001} on their side walls. It was revealed that the initial pH of the aqueous Ce salts solution was a key parameter to attain the anisotropic growth of the CeO_2 mesocrystals. We thus proposed a formation mechanism of CeO_2 nanowires and nanorods considering these conditions.

In ***Chapter 4 "CeO_2 Film Fabrication by G-LPD Process"***, crystalline CeO_2 films were fabricated on the plastic PES substrates and metal Ni substrates without their seed layers at a low process temperature of 60 °C by the G-LPD process using readily available metal salts such as nitrates and chlorides. This chapter revealed that the pH value of the starting material solution was an important parameter to fabricate crystalline CeO_2 films, and they were fabricated in the pH range calculated in ***Chapter 2***.

Chapter 5 "ZnO Film Fabrication by G-LPD Process Using Ethylene Glycol" showed that crystalline ZnO films were fabricated on the PES substrate without their seed layers at a low process temperature of 60 °C by the G-LPD process using ethylene glycol as solvents. This modification suppressed the heterogeneous nucleation and crystal growth at the gas-liquid interface and achieved those at the solid-liquid interface. The fabricated ZnO films had continuous film structure because of the adhesion of EG to the crystals, and they exhibited visible light transmittance greater than 60% and the decrease in the resistivity under UV-A irradiation.

The thesis was summarized in ***Chapter 6 "General Conclusions"***.

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 1copy of 800 Words (English).