

研究論文

YBa₂Cu₃O_{7-δ}の酸素発生反応電気化学触媒機能の結晶構造依存性

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Crystal Structure Dependence of Oxygen Evolution Reaction for YBa₂Cu₃O_{7-δ} as Electrochemical Catalyst

by

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Abstract

Oxygen evolution reaction (OER) is an essential part of the electrolysis of water in the fields of renewable energy and rechargeable metal–air batteries. However, since the large overpotential of OER causes an energy loss in electrolysis of water, an appropriate OER electrocatalyst is required. In this report, the function of YBa₂Cu₃O_{7-δ} (YBCO) was investigated as a new OER catalyst, which enhances the activity because of the reaction mechanism caused by oxygen deficiency. YBCO samples were synthesized via a sol-gel reaction and calcined at 760, 820 and 920 °C. Crystal structures were determined by powder X-ray Diffraction (XRD). The overpotentials of YBCO as an OER catalyst were measured by Rotating Ring Disk Electrodes (RRDE). OER activity of YBCO is superior to a bare glassy carbon and carbon black with regards to OER overpotential and *Tafel* slope. Moreover, the crystal structure of YBCO may play a role in the enhancement of OER activity. Tetragonal YBCO exhibits better OER catalyst activity than that of orthorhombic YBCO.

Keywords: Oxygen evolution reaction, electrocatalyst, layered oxide with oxygen deficiency, YBa₂Cu₃O_{7-δ} (YBCO)

1. 緒言

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金属空気二次電池¹⁾や水素燃料を得るための水の電気分解反応²⁾⁻⁴⁾において酸素発生反応 (Oxygen Evolution Reaction, OER) は重要である。OERは多段階な電子移動反応が律速であるため、過電圧が生じる。反応電流密度、すなわち反応速度も小さいため、金属空気二次電池においては、充電時の負極の酸化反応がOERより顕著となり電極材料の劣化を招く。水の電気分解反応においてはOERの過電圧の大きさは外部からの印加電圧を大きくする必要が生じ、反応に必要な電力を増大させる技術的な課題がある。このOERの反応効率向上に触媒としての電極を必要とする。実用的な既存のOER触媒はIrやRuのような貴金属の氧化物^{5),6)}である。既存のOER触媒の原材料は高価であり、大規模な工業設備やインフラに導入するには高い費用を要するため、普及への障壁となっている。より安価で高触媒能を