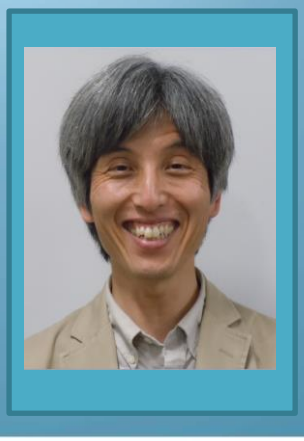
MSE-Colloquium@NTU

20 June 2018, 2:00 pm

Lecture Theatre 6, Nanyang Technological University, Singapore



Photoelectrochemical Water Oxidation using n-type GaN Single Crystal with/without NiO Loading

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Abstract

Energy conversion from solar to chemical energy is an important technology to store solar energy. Photoelectrochemical conversion is studied as a means to directly convert solar energy due to its easy setup and theoretical interest. In this presentation, n-type GaN single crystal is discussed as the photoanode for photoelectrochemical water splitting.

Due to its large bandgap, n-type GaN is not ideal for photoanodes, however it is a suitable material to study the photoelectrochemical process due to its chemical stability. However, even n-type GaN shows anodic corrosion under photoelectrochemical oxidation conditions. Experimental results show that the kind of electrolytes and the density of point defects affect the stability but the dislocation density does not affect stable operation. That is, n-type GaN is relatively stable in aqueous NaOH solution with relatively low Si doping. Even under these conditions, the anodic corrosion of n-type GaN is not suppressed completely.

Carrier transfer evaluation is helpful to understand this anodic corrosion process. From comparison with photoluminescence (PL) and photoelectrochemical water oxidation experiments, an intermediate hole trap with long life time, i.e. yellow luminescence (YL) in PL studies, is thought to be related to water oxidation. The carrier transfer process from the intermediate state to the reactant in the electrolyte is, however, estimated to be relatively slow. Therefore, it is estimated that the carrier transfer from the intermediate state to the reactant reaches the limited rate soon, hence the anodic reaction of GaN occurs easily. When NiO is loaded on the n-type GaN, the anodic corrosion is suppressed completely. From the evaluation of the optical properties of n-type GaN with/without NiO loading, the hole accumulation at the NiO probably plays the role of the reaction centre of water oxidation.

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Biography

Professor Katsushi Fujii (PhD Science) received his B.Eng and PhD degrees from Osaka University in 1983 and 1994 respectively. He joined Mitsubishi Chemical Corporation in 1983. From 2004, he worked on the “Nakamura inhomogeneous crystal project” of JST (2004 – 2006). He subsequently became a Visiting Associate Professor at the Centre for Interdisciplinary Research (CIR) at Tohoku University and a Professor at the School of Environmental Science (2006 – 2011), a Project Professor under the Global Solar+ Initiative (GS+I) at the University of Tokyo (2011 – 2015), a Research Scientist at the Centre for Advanced Photonics, RIKEN (2015 – 2016), and a Professor at the Institute of Environmental Science and Technology, University of Kitakyushu (2016 – 2017). Since 2017, he has been a Research Scientist at the Centre for Advanced Photonics, RIKEN.

His current areas of research interest are energy storage systems, energy conversion from sunlight to chemical energy (hydrogen evolution from water and carbon dioxide reduction), electrochemistry, and semiconductor science.

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