理工学部講演会

Tuning the Structure of MnO_2 Catalysts for Enhanced Bifunctional Oxygen Reduction /Evolution Reaction in Rechargeable Metal-Air Batteries

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日時：7月31日（金）15：00～17：00

場所：VII号館112号室

大容量の革新的二次電池として金属-空気二次電池が期待されている。この成功のカギを握っているのが、酸素の酸化/還元反応をつかさどる触媒である。講演では、期待される触媒の最新研究成果を議論していただく。

（言語：English）

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Tuning the Structure of MnO_2 Catalysts for Enhanced Bifunctional Oxygen Reduction / Evolution Reaction in Rechargeable Metal-Air Batteries

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Development of active, durable and cost-efficient bifunctional electrocatalysts for oxygen reduction and evolution reactions (ORR and OER) is of outmost importance to realize the full potential of rechargeable metal-air batteries (e.g., Zn-air, Al-air, Mg-air, Li-air) and regenerative H_2-O_2 fuel cells. Manganese oxides (MnO_x) have been intensely studied especially for alkaline ORR electrocatalysis. Regarding the bifunctional ORR and OER electrocatalytic performance of MnO_x, however, improvements in activity and durability are required for implementation in commercial energy storage and conversion systems. Novel approaches are presented to enhance the bifunctional activity and durability by tuning the MnO_2 catalyst structure with co-catalyst addition, potassium ion doping and support effect (e.g., graphene and graphitized carbon). The combination of MnO_2 with a structurally different oxide co-catalyst such as perovskite ($LaCoO_3$) or fluorite-type oxide (Nd_3IrO_7) produces a synergistic catalytic effect improving the activity compared to the individual oxides. Doping of the oxide catalyst with potassium ions, either by long-term exposure to 6 M KOH or potential driven insertion (PDI), increases further the activity and durability as revealed in accelerated degradation experiments.[1,2] The effect of MnO_2 morphology on the bifunctional performance is demonstrated using a comprehensive statistically designed MnO_2 electrodeposition study. Optimizing the MnO_2 electrodeposition conditions can produce nanostructured morphologies that are favorable for bifunctional activity.[3] The electrochemical results are supported by extensive surface analysis (SEM, TEM, XPS, EDX, EELS) and explanation of the results is provided based on the scaling relationship between the binding energies of HO^* and HOO^* species.

References:

1. P. H. Benhangi, A. Alfantazi and E. Gyenge, *Electrochim. Acta*, 123, 42 (2014).

2. P. Hosseini-Benhangi, M. A. Garcia-Contreras, A. Alfantazi and E. L. Gyenge, *J. Electrochem. Soc.*, 162, F1356 (2015).

3. P. Hosseini-Benhangi, C.H. Kung, A. Alfantazi and E.L. Gyenge, *submitted ACS Appl.Mat. & Interfaces* (2017).