Modulation of Oxygen Evolution Reaction by Cavity-Arrayed Electrode: Cavity-Length Dependence

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Keywords: Oxygen Evolution Reaction; Catalyst; Vibrational Strong Coupling; Cavity - arrayed Electrode.

[Introduction] Oxygen evolution reaction (OER) is the counterpart reaction in the hydrogen evolution reaction at water electrolysis. The large overpotential of the OER limits the hydrogen production from water. Recent studies highlight that the modification of hydration structure by electrolyte can modulate the OER activity.[1] It also has been proposed that the utilization of the cavity vacuum field for the modification of the energy landscape in the chemistry under the formation of polaritons.[2] Here, we utilized the cavity-arrayed electrode to enhance the OER activity.

[Methods] Cavity-arrayed electrodes were fabricated by the laser lithography method, dry etching and Ni deposition. By controlling the time for the dry etching, the depth of the cavity structure can be controlled, in my research, I fabricated electrodes with cavity structure depths of 0.2 μm and 1.0 μm. The cavity-arrayed electrode, Ag/AgCl, and Pt black were utilized as the working, reference, and counter electrodes, respectively. 1 M $NaClO_4$ + 3 mM NaOH (pH = 11) was used as the unbuffered electrolyte solution. The video camera was utilized for the observation of the bubble formation process at OER.

[Results and Discussion] Figure showed the image of the randomly cavity-arrayed electrodes. Due to the presence of the cavity mode, the apparent color of the electrode is dependent on the cavity length. The array of the structures of the given cavity length were randomly arranged to avoid the experimental artifact from the position-dependent activity. We evaluated the OER activity from the cavity-arrayed electrode. In the case with the larger depth, 1.0 μm, the oxygen bubbles formation were dependent on the cavity, but were not with the smaller depth, 0.2 μm. The results suggest the modulation of the OER activity through the cavity-arrayed electrode.

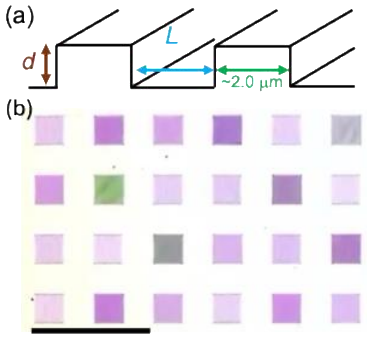

Figure. (a) Schematic structure of the cavity-arrayed electrode. *L* : cavity length. *d* : depth. (b) Snapshot of cavity array electrode for *d* = 1.0 μm. *L* can be varied between 1.0 μm and 5.6 μm. Scale bar = 500 μm.

References

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