

Functionalization of Isotopic Hydrogen Evolution Reactions using Nano-Structured Electrodes

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The isotopic selectivity of the hydrogen evolution reactions (HER) is quite complicated process. It has been reported that the isotopic selectivity strongly depended on the various factors, such as the electrode potential, solution temperature, or the concentration of D₂O.¹ Although various approaches have been conducted, the arbitrary tuning of the isotopic selectivity is a key issue for the chemists. By contrast, the surface process at the nanostructured interface can be modulated due to the confined electric field. Recently, we have successfully found the change in the isotopic selectivity depending on the morphology of the electrode surface.² In addition, the unique isotopic selective molecular condensation was observed at the specific nanostructured interface using electrochemical spectroscopic method. From those backgrounds, in this study, we have constructed the various nano-structured metal electrodes to examine the isotopic reaction selectivity of the HER for the functionalization of the isotopic HER process.

The nano-structured electrodes, we have prepared the well-defined Ag structures by using the polystyrene-based template methods (Ag-NSL) on the glassy-carbon (GC) electrodes. For the detail discussion about the isotopic reaction selectivity on the nano-structured electrode, the electrochemical mass spectroscopy system has been applied.² Figure shows the separation factor (S_D) values which can be used as the indication for the isotopic selectivity for each electrode. As indicated in the figure, it was found that the unique isotopic selectivity can be seen on the nano-structured Ag-electrode compared to the normal Ag electrode. From the theoretical kinetic simulations, it was found that the specific surface process was selectively accelerated on the nano-structured electrode. In addition, it was also found that the tuning the metal species or morphologies allowed us to switch the H₂ to D₂ generations. Through all attempts, we have successfully achieved the functionalization of isotopic selectivity on HER for the first time.

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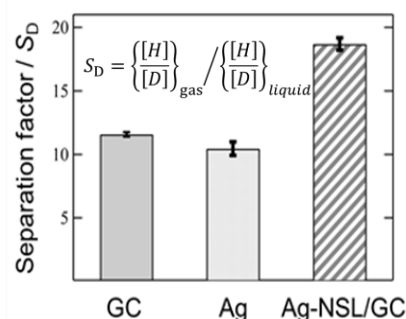


Fig. Estimated S_D values for GC, Ag and Ag-NSL/GC electrodes. Each value was obtained from mass spectra by using GC, Ag, and Ag-NSL/GC electrodes. The electrolyte solution was 0.5 M Na₂SO₄ aq. solution containing 90 mol% D₂O.