

## Investigation for Catalytic Electrochemical Reduction of Acetic Acid

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Liquid fuels such as ethanol and ammonia, are candidates as next-generation energy carriers, because they have advantages in transportation and storage compared with hydrogen gas. One of the goals of our division is to realize the “Carbon-Neutral Energy Cycle” using the liquid fuels. In this project, we have focused on the reduction part of the ethanol fuel from waste of the cycle (in other words, ethanol synthesis from acetic acid) and have tried to create electrode catalysts for the reduction reaction.

The goal of this project is to achieve electrochemical synthesis of ethanol from acetic acid. However, there is no report on the electrode catalysts for the reaction. We firstly tried to clarify the catalytic activity of various metals for the reaction reduction. We evaluated catalytic activity of 3d, 4d, and 5d elements by Cyclic Voltammetry using metal specimens (Ti, V, Cr, Fe, Co, Ni, Cu, Zn, Zr, Nb, Mo, Rh, Pd, Ag, Ta, W, Re, Ir, Pt, and Au) as the working electrode (Figure 1). We found that the group 10 elements (Ni, Pd, and Pt) show relatively-high onset potentials for the reduction, suggesting that these elements potentially have the catalytic activity for reduction of acetic acid. We also found that the pH of the reaction solution is very important for this reaction, and that pH 5 is favorable condition for the reaction. We have synthesized the catalysts of carbon-supported Pt, Pd, and Ni metals by impregnation method. The carbon-supported catalysts were characterized by X-ray diffraction and transmission electron microscope measurements. We found that metal nanoparticles of these elements were successfully formed on the carbon support with typical face-centered cubic crystal structure.

We have applied these catalysts to the electrolysis cell with a flow of mixture of 0.1 M acetic acid and 0.5 M Na<sub>2</sub>SO<sub>4</sub> (support electrolyte) as shown in the Figure 2. The pH of the solution was fixed to 5.00. The carbon-supported catalysts were loaded on a carbon paper. The liquid and gas products were detected by NMR measurements.

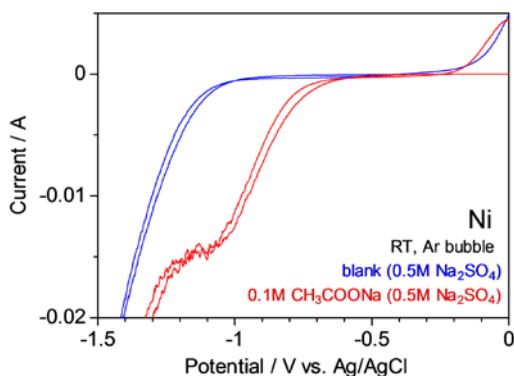


Fig. 1. Cyclic Voltammogram for Ni electrode.

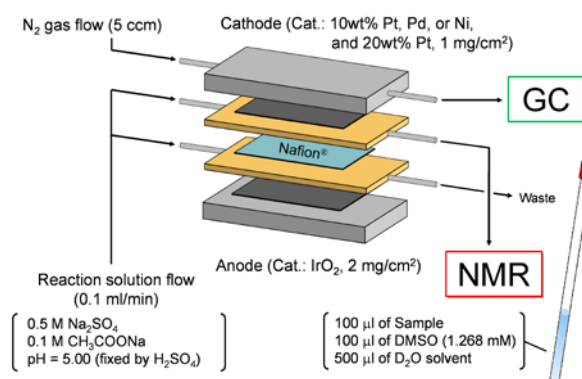


Fig. 2. Schematic view of the electrolysis cell.