

Rare-earth intermetallic such as LaNi_5 as catalyst in electrohydrogenation reaction of organic compounds

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Since metal hydrides were known to present a rapid and reversible hydrogen adsorption capacity at around room temperature and ambient pressure, they possess a high potential for uses as hydrogen storage substances and then they have received and are still receiving much attention.

The physicochemical characteristics of these materials have been extensively studied and many applications have been explored. Metal hydride electrodes have been developed and commercially applied in nickel-metal hydride batteries, which advantageously replace nickel-cadmium batteries. The properties of the rare-earth intermetallic hydrides can also be used in heterogeneous catalysis, more particularly in hydrogenation reactions.

In the laboratory, we have been interested in the properties of intermetallic compounds such as LaNi_5 , in direct electrocatalytic hydrogenation of organic substrates. This way does not require extreme experimental conditions, as the reactions are conducted at room temperature and under ambient pressure, what represents a positive point. According to our previous results, the intermetallic compound way of run can be explained as represented on the scheme 1. During the electrochemical reduction step, the intermetallic compound absorbs hydrogen to form the hydride LaNi_5H_x . When an unsaturated organic compound is brought into contact with it, hydrogen is released from the hydride, which has its initial form back, and the hydrogenation of the unsaturated compound is observed

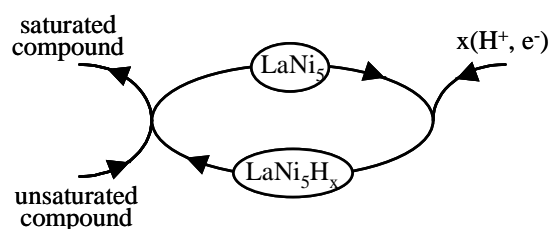
The work that we would like to present here is devoted to the electrocatalytic properties displayed by LaNi_5 in different solvents. Different unsaturated organics compounds were tested at a preparative scale. The results concerning the hydrogenation of 3-penten-2-one in $1 \text{ mol.L}^{-1} \text{ KHCO}_3$ are presented in figure 1 as an example. In this aqueous medium, 100% Faradaic efficiency towards the olefinic hydrogenation is obtained. Note that the hydrogenation of the carbonyl group is not observed.

According to these optimistic results, we have envisaged modifying the intermetallic compound with nanoparticles of platinum, which is known to be an excellent catalyst concerning hydrogenation reactions. Two different ways are tested to obtain these nanoparticles: according to the polyol process in order to access to platinum particles distributed at the surface of the LaNi_5 powder and by substitution of Ni in Pt during the alloy preparation.

In order to understand and explain how the properties change with the platinum rate, we made an electroanalytical study using powder microelectrodes. Some of the results obtained are presented on the figure 2.

The evolution of the voltammograms seems to predict a very interesting behavior of the platinum.

All these results will be discussed on the occasion of the 203rd Meeting of The Electrochemical Society.



Scheme 1: schematic representation of the charge/discharge cycle of LaNi_5 during the hydrogenation process.

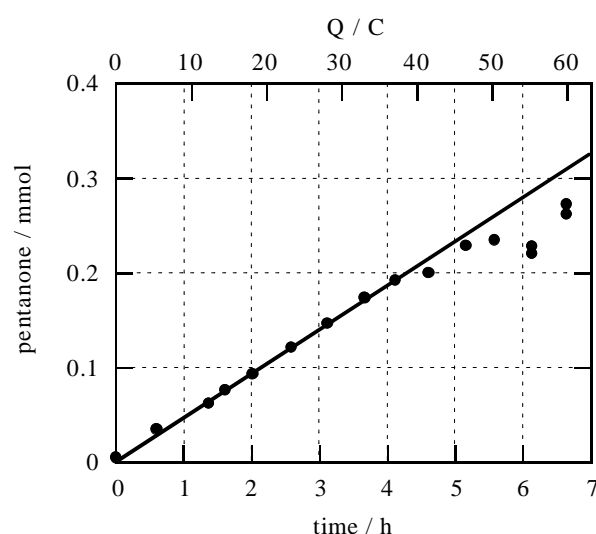


Figure 1: the product formation vs. time for the electrocatalytic hydrogenation of 3-penten-2-one with LaNi_5 in $1 \text{ mol.L}^{-1} \text{ KHCO}_3$

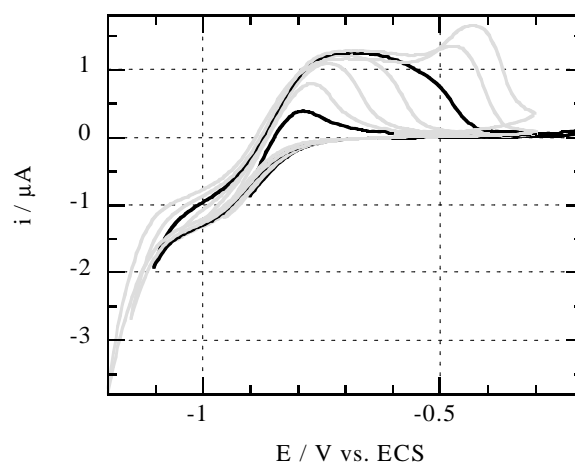


Figure 2: voltammograms for $\text{LaNi}_{4.5}\text{Pt}_{0.5}$. 25 μm diameter cavity microelectrode; scan rate = 50 mV.s^{-1} ; in $1 \text{ mol.L}^{-1} \text{ KHCO}_3$

