Synthesis and Characterization of Nickel Cobalt Catalysts

Gitana Valeckytė, Zita Sukackienė, Jūratė Vaičiūnienė, Loreta Tamašauskaitė-Tamašiūnaitė, Eugenijus Norkus
Department of Catalysis, Center for Physical Sciences and Technology (FTMC),
Saulėtekio al. 3, LT-10257 Vilnius, Lithuania
gitana.valeckyte@ftmc.lt

Significance and Relevance

The production of high-purity hydrogen from hydrogen storage materials with further direct use of generated hydrogen in fuel cells is still a relevant research field. For this purpose, nickel cobalt-plated copper catalysts (NiCo/Cu), comprising between 4 and 90 wt.% cobalt, as catalytic materials for hydrogen generation, were prepared using a low-cost, straightforward electroless metal deposition method by using citrate plating baths, a metal source and morpholine borane as a reducing agent. The catalytic activity of the prepared NiCo/Cu catalysts toward alkaline sodium borohydride (NaBH4) hydrolysis increased with the increase in the content of cobalt present in the catalysts.

Preferred and 2nd choice for the topic: Sustainable and clean energy production and transport; H2 storage and transportation, green H2 production, hydrogen vectors
Preferred presentation: (Oral only / Oral preferred or Short Oral / Poster) *Poster*

Introduction and Motivations

Hydrogen is a good alternative to coal, oil and natural gas [1]. The reason we need to replace fossil fuels is that they are constantly depleting, and when burned, the products of such fuels pollute the environment and cause the greenhouse effect, thus contributing to climate change. Although the majority of hydrogen is produced from natural gas (62 %), coal (19 %), or naphtha reforming (18 %), it can be change. Extremely pure hydrogen is obtained during the borohydride hydrolysis reaction, which can be directly used as a hydrogen fuel cell. In addition, fuel cells using pure hydrogen emit almost no pollutants other than water [2].

Materials and Methods

The aim of this work was to identify NiCo(4)/Cu, NiCo(10)/Cu, NiCo(20)/Cu, NiCo(80)/Cu and NiMo(90)/Cu catalysts, characterize them and evaluate their catalytic properties for sodium borohydride for the hydrolysis reaction. All NiCo coatings were deposited on a Cu substrate by a simple chemical deposition method using morpholine borane as a reducing agent. Catalysts were obtained with different cobalt mass percentages: 4, 10, 20, 80 and 90. The surface morphology, structure and chemical composition of the catalysts were investigated using scanning electron microscopy (SEM) and induced plasma optical emission spectroscopy (ICP-OES). The catalytic effect of the sodium borohydride hydrolysis reaction was evaluated by measuring the amount of hydrogen present in the catalyzed borohydride hydrolysis reaction.

Results and Discussion

During the work, all the mentioned NiCo/Cu catalysts were formed. Their morphology and structure were investigated. It was established that the prepared coatings consist of particles of various sizes that are combined into oval-shaped agglomerates. It was found that the two-component NiCo/Cu with 90 mass percent exhibited the highest catalytic activity. This catalyst was found to have an activation energy of 52.5 kJ/mol and an H_2 evolution rate of 1.46 mL/min at 30 °C and 15.61 mL/min at 70 °C. The synergetic effect between nickel and cobalt, in addition to the formation of solid-state solutions between metals, promoted the hydrogen generation reaction.

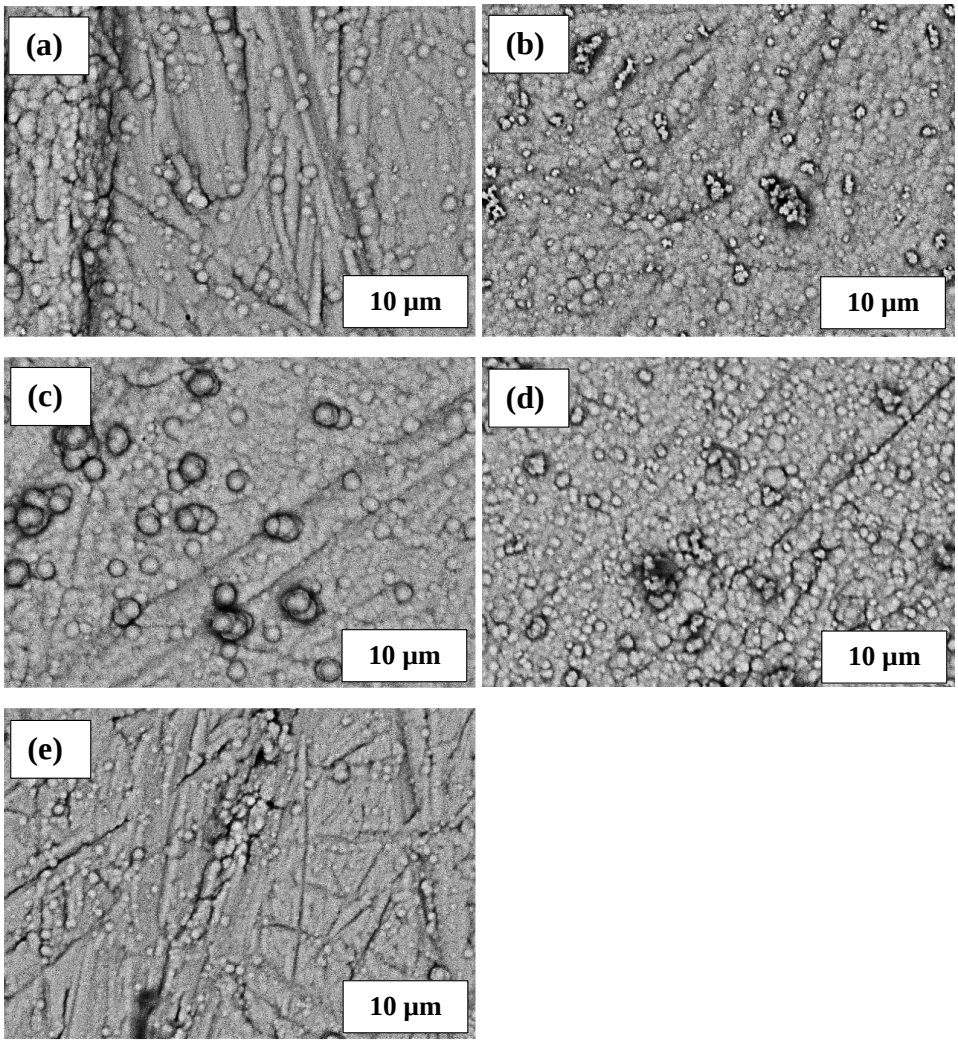

Figure 1 SEM images of prepared NiCo(4)/Cu (a), NiCo(10)/Cu (b), NiCo(20)/Cu (c), NiCo(80)/Cu (d) and NiCo(90)/Cu (e)

References

1. F. Alasali, M.I. Abuashour, W. Hammad, D. Almomani, A.M. Obeidat, W. Holderbaum, *Energy Science and Engineering.* **2024**, *12*, 1934–1968.
2. L. Van Hoecke, L. Laffineur, R. Campe, P. Perreault, S. W. Verbruggen, S. Lenaerts, *Energy and Environmental Science*, **2021**, *14*, 815-843.

Acknowledgements

Research Council of Lithuania for funding of grant.