Impact of the support on the activity and stability of Ir catalysts under the Dry Reforming of Methane conditions.

E. Nikolaraki[1], P. Panagiotopoulou[1], G. Kyriakou[2], D.I. Kondarides[2], D.I. Gournis[1,3] and I.V. Yentekakis[1,3*]

[1] *School of Chemical and Environmental Engineering, Technical University of Crete, Chania, Hellas*

[2] *Department of Chemical Engineering, University of Patras, Patra, Hellas*

[3] *Institute of Geoenergy / Foundation for Research and Technology-Hellas (IG/FORTH), 73100 Chania, Crete, Hellas*

**yyentek@isc.tuc.gr*

Keywords: Dry Reforming of Methane, Ir, Syngas, ceria-zirconia mixed oxides, greenhouse gases

Uncontrolled emissions of greenhouse gases cause global warming and subsequent climate change. Dry Reforming of Methane (DRM) is a promising catalytic process as it converts two major greenhouse gases (CH_4 and CO_2) into synthesis gas ($CO+H_2$), providing an efficient way to directly use biogas and recycle CO_2 emissions [1]. Syngas is a key feedstock for the petrochemical industry for producing liquid fuels, blue hydrogen, and high-value chemicals. The biggest challenges of the DRM process in practical applications are catalyst deactivation due to thermal sintering and carbon deposition [1]. In this study, the effect of support on the DRM performance (activity and selectivity) of Ir nanoparticles, carbon deposition phenomena, and their stability under reaction (at 500-750°C) and/or after oxidative thermal aging conditions is investigated. Supports studied include γ-Al_2O_3, Alumina-Ceria-Zirconia (ACZ), and Ceria-Zirconia (CZ). Their textural, structural and physicochemical properties, as well as those of the corresponding supported Ir catalysts, were determined using various techniques, such as BET, XRD, HRTEM, H_2-TPR, H_2-chemisorption, ICP-OES, and TPO. All catalysts studied were found to be highly stable under DRM conditions, while the carbon deposition rate was particularly low for all, although there seemed to be a clear decreasing trend in carbon deposition: Ir/γ-Al_2O_3 > Ir/ACZ > Ir/CZ. It was also found that Ir/CZ and Ir/ACZ catalysts, due to their high population of oxygen defects (oxygen vacancies), favor the conversion of CO_2, thereby producing syngas enriched in CO. They also promote carbon removal through a bifunctional reaction mechanism. It was also demonstrated that supports with sufficient mobile lattice oxygen enhance the resistance to agglomeration of sensitive Ir crystallites, even under intense (~750°C) oxidative thermal aging conditions. In summary, Ir nanoparticles dispersed on CZ-based supports appear to be highly promising catalysts for the DRM reaction at low temperatures.

Acknowledgments

The research project is implemented in the framework of H.F.R.I call "Basic research Financing (Horizontal support of all Sciences)" under the National Recovery and Resilience Plan "Greece 2.0" funded by the European Union – NextGenerationEU (H.F.R.I. Project Number: 16916).

H.F.R.I. Hellenic Foundation for Research & Innovation
Greece 2.0 NATIONAL RECOVERY AND RESILIENCE PLAN
Funded by the European Union NextGenerationEU

References

[1] I.V. Yentekakis, P. Panagiotopoulou, G. Artemakis, Appl. Catal. B Environ. 296 (2021) 1201210.