

GaNi Supported Catalytically Active Liquid Metal Solutions: efficient class of catalysts for the selective oligomerisation of ethylene

Yousuf Raed Ramzi¹, Johanna Nisselbeck¹, Nicola Taccardi¹ Marco Haumann¹ and Peter Wasserscheid^{1,2}

¹ Lehrstuhl für Chemische Reaktionstechnik (CRT), Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Erlangen, Germany

² Helmholtz-Institut Erlangen-Nürnberg für Erneuerbare Energien (IEK-11), Forschungszentrum Jülich, Erlangen, Germany

Abstract

The selective oligomerization of short alkenes provides a direct route to a wide range of chemical products of substantial interest such as butenes, octenes and other industrial products.¹ Homogeneous, Ni-based catalysts are employed to provide high selectivity and product separation is achieved in the industrial process by means of miscibility gap. Typical heterogeneous catalysts used in the oligomerization reaction do not provide high stability, selectivity, and yield toward the desired linear products. Recently, *supported catalytically active liquid metal solutions* (SCALMS) were developed as a new class of materials where small amounts of an active metal (e.g. Pt, Ni) are integrated in a low melting metal (e.g. Ga) matrix, resulting in liquid alloys at reaction conditions.² In this contribution, we demonstrate the preparation of the GaNi SCALMS materials using physical impregnation method and the applicability and durability of the catalysts for the selective ethylene oligomerization reaction.

The effect of the Ga/Ni ratio on the catalytic performance in ethylene oligomerization was investigated (**Figure 1**). The results show an increase in the conversion of ethylene with a higher Ga/Ni ratio. The effect of the higher Ga/Ni ratio has an influence on the productivity while the selectivity towards dimers remains constant with changing Ga/Ni ratio. All the tested GaNi SCALMS materials were stable during the experiments, with the robustness attributed to the highly dynamic nature of the SCALMS liquid metal/gas interface. This performance enabled kinetic measurements to further understand the GaNi SCALMS materials.

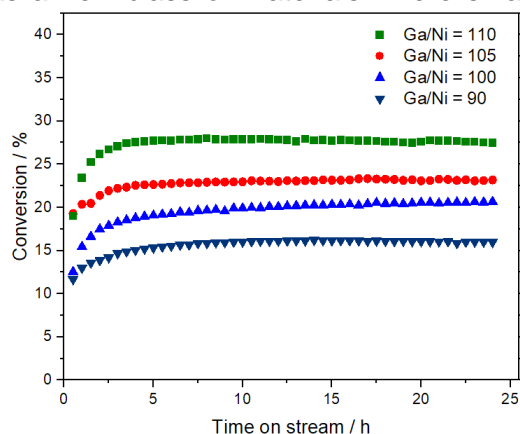


Figure 1. Conversion vs. time for the synthesized GaxNi-SCALMS catalysts tested in the oligomerization of ethylene.

References

1. Finiels, A., Fajula, F. & Hulea, V. Nickel-based solid catalysts for ethylene oligomerization-a review. *Catal Sci Technol* **4**, 2412–2426 (2014)
2. Søggaard, A. et. al. Ga–Ni Supported Catalytically Active Liquid Metal Solutions (SCALMS) for Selective Ethylene Oligomerization, *Catal. Sci. Technol.* 2021, **11**, 7535