Structural Evolution of GaO_x-Shell and Intermetallic Phases in GaPt Supported Catalytically Active Liquid Metal Solutions

S. Carl[1], J. Will[1], N. Madubuko[2], A. Götz[1], T. Przybilla[1], M. Wu[1], N. Raman[2], J. Wirth[1], N. Taccardi[2], B. Apeleo Zubiri[1], M. Haumann[2], P. Wasserscheid[2,3], E. Spiecker[1]

[1] Institute of Micro- and Nanostructure Research (IMN) & Center for Nanoanalysis and Electron Microscopy (CENEM), Interdisciplinary Center for Nanostructured Films (IZNF), Friedrich-Alexander-Universität (FAU) Erlangen-Nürnberg, Germany

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

[3] Forschungszentrum Jülich GmbH, Helmholtz-Institute Erlangen-Nürnberg for Renewable Energy (IEK 11), Egerlandstr. 3, 91058 Erlangen, Germany

E-Mail presenting author: sim.carl@fau.de

We developed a novel scale-bridging identical location (IdL) characterization approach on the GaPt SCALMS system for propane dehydrogenation (PDH), utilizing X-ray microscopy (XRM), nano X-ray computed tomography (nano-CT) and correlative analytical transmission electron microscopy (TEM) [1], [2].

The imaging modalities of the nano-CT instrument allowed for comprehensive 3D studies of the GaPt alloy particles prepared by ultrasonication and galvanic displacement [3]. The dynamic transformations of the alloy particles observed ex-situ by nano-CT during catalytic conversion conditions in a lab-scale catalytic reactor offered new insights into the presence and structural evolution of the gallium oxide (GaOx) shell during catalytic reaction, such as the evolution of hollow GaOx structures. By subsequent cross-section scanning transmission electron microscopy and energy dispersive X-ray spectroscopy (STEM-EDXS) analyses of focused-ion beam (FIB) milled lamellae of selected representative GaPt alloy droplets before and after catalysis, we were able to investigate the morphological and chemical evolution of the GaPt SCALMS system during PDH. With this, we were able to highlight the complexity of this dynamic catalyst system and demonstrated the important role of Pt segregation towards the oxide shell during PDH, leading to the formation Pt-rich GaPt intermetallic phases.

[1]Taccardi et al., *Nat. Chem.*, 2017, 9, 862-867 (2017), https://doi.org/10.1038/nchem.2822

[2] S. Carl *et al., Phys. Chem. Lett.*, 2024, 15, 17, 4711–4720, https://doi.org/10.1021/acs.jpclett.3c03494.

[3] N. Raman *et al.*, *ACS Catal.*, 2021, 11, 21, 13423-13433, https://doi.org/10.1021/acscatal.1c01924