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Degradation and regeneration analysis of noble metal ex-solution catalysts for dry and steam methane reforming

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Dry Methane Reforming (DRM) and Steam Methane Reforming (SRM) are among the proposals for reliable and environmentally friendly hydrogen production methods. However, these two processes are highly driven by temperature and can be enhanced by the proper catalysts. Coking is a major problem for conventional catalytic materials, especially in DRM cases[2]. As a solution to this problem, metal ex-solved nanoparticles on the surface of the perovskite material were proposed as promising catalysts[2,3]. Platinum and ruthenium are both of great interest in DRM and SRM. With use of noble metals arises the problem of scarcity and materials price. We propose to mitigate this by employing regeneration procedures, which can extend the lifetime of already-durable catalysts to even longer times.

Catalysts were synthesized by modified Pechini method and characterized by X-Ray Diffraction (XRD) and Scanning Electron Microscopy studies (SEM). Catalytic activity and durability tests were carried out. SEM imaging of the ex-solved ruthenium particles and methane conversion ratio in dry reforming setup are shown on figures below.

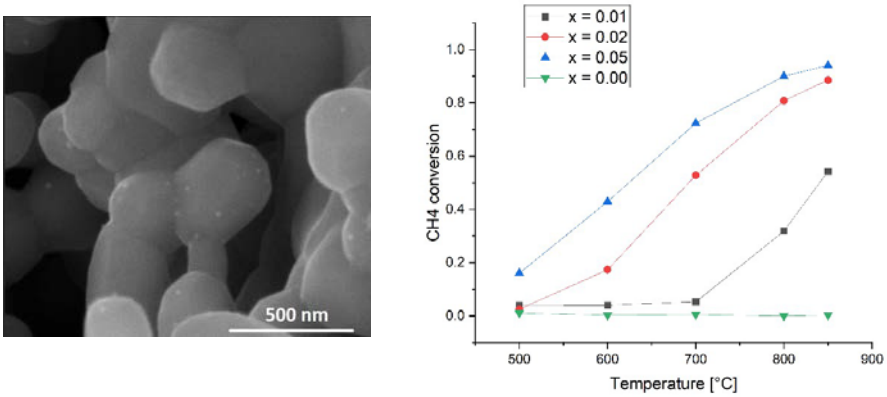

Fig 1. SEM image of ruthenium nanoparticles (left) and efficiency in the dry methane reforming process for different Ru doping levels (right)

The regeneration procedure was studied by employing synchrotrone radiation for low- energy X-Ray Absorption (XAS) and X-Ray Photoelectron spectroscopy (XPS) at PHELIX beamline in Solaris, Kraków. $(La_{0.3}Sr_{0.7})_{0.9}Ti1\text{-}xPt_xO_{3+\delta}$ and $(La_{0.3}Sr_{0.7})_{0.9}Ti1\text{-}xRu_xO_{3+\delta}$ polycrystalline perovskite samples for different doping levels were investigated. Research was concentrated on exploring ex-solution characteristics, degradation of the samples after durability tests and effectiveness of regeneration procedures.

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