Degradation of atmospheric plasma sprayed MCF protection coatings in planar SOFCs

N. Grünwald[1*], N. H. Menzler[1], O. Guillon[1,2] and R. Vaßen[1]

[1]*Forschungszentrum Jülich GmbH, Institute of Energy and Climate Research – Materials Synthesis and Processing (IEK-1), 52425 Jülich, Germany*
[2]*JARA-Energy, Jülich/Aachen*

(*) n.gruenwald@fz-juelich.de

Chromium containing steels are commonly used in solid oxide fuel cell (SOFC) stacks as interconnect (IC) material. Unfortunately, chromium species evaporating from the IC might react with the cathode material causing serious cell degradation, known as chromium poisoning.

Applying thin and dense protective coatings between IC and cathode has proven to be an effective way to diminish chromium poisoning enabling long-term stack and system operation. An SOFC stack with an atmospheric plasma sprayed (APS) manganese cobalt ferrite (MCF) spinel protective layer showed a remarkable low degradation rate of 0.2 %/kh for nearly 35,000h of operation at Forschungszentrum Jülich. Nevertheless, the coating undergoes microstructural changes and phase transitions, which have not been fully understood so far. A decomposition of the spinel powder to Fm-3m cubic structure during plasma spraying and transition to spinel phase within subsequent annealing was reported [1-3]. It should be noted, that these studies using X-ray diffraction (XRD) were concentrating on the MCF layer's surface. A closer look to the MCF microstructure of samples annealed in air reveals an inhomogeneous layer composition near the sample surface facing the air. Figure 1 shows a scanning electron microscopic (SEM) image and an energy dispersive X-ray spectroscopic (EDX) mapping of cobalt and manganese of a sample annealed for 100 hours at 800°C. Considering the X-rays penetration depth, the measured signal will be dominated by the upper cobalt-rich surface that is formed during annealing. The bulk material shows a different microstructure as indicated by the SEM picture in Figure 1.

Further investigations of plasma sprayed MCF on Crofer22APU substrates have been performed to understand the origin of the alteration and estimate the effects on the coating stability and its impact on Cr diffusion. Systematic studies (within a project funded by the German Federal Ministry of Education and Research, grant No 03SF0494A) will reveal the basic degradation mechanisms and help to improve the life-time of the SOFC stack.

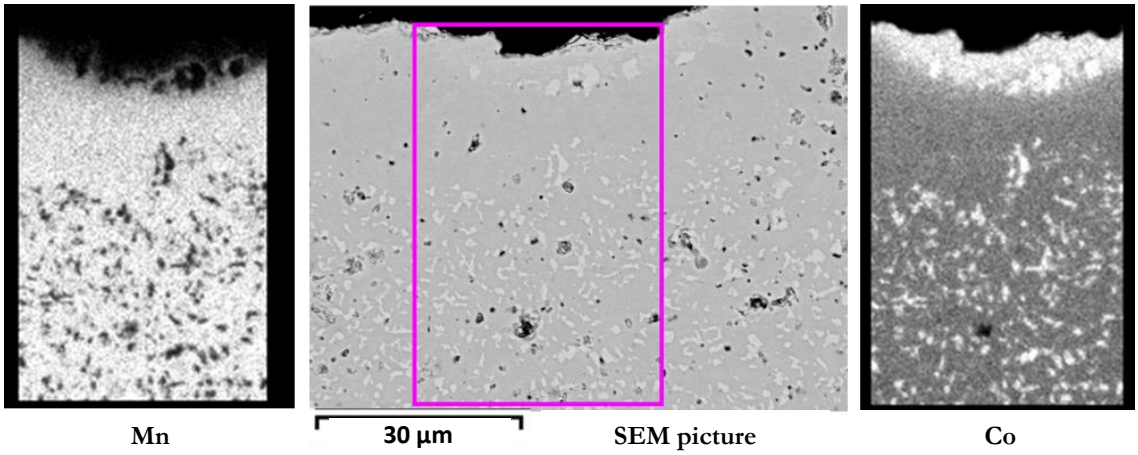

Figure 1. SEM picture (middle) and EDX mapping of manganese (left) and cobalt (right) of the MCF-layer of a sample annealed for 100 h at 800°C in air.

References

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