Curriculum Vitae – Andreas Nenning

NENNING, Andreas

Born: Sep 17th, 1987 in Austria

Institute of Chemical Technologies and Analytics, TU Wien

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Education

2016: Ph.D. in Chemistry, TU Wien

2013: MSc. (Dipl.-Ing.) in Physics, TU Wien

2011: BSc. in Physics, TU Wien

Work experience

2018-present: Postdoctoral researcher at *TU Wien*, division "Technical Electrochemistry"

2016-2018: Postdoctoral researcher at *ETH Zurich* (CH) and *Massachusetts Institute of Technology* (Cambridge, USA), Research Group "Electrochemical Materials" led by Prof. Jennifer Rupp

2013-2016: PhD position at TU Wien, research group "Solid State Ionics" led by Prof. Jürgen Fleig

Research interests

Andreas' research focuses on improving models and descriptors for the catalytic properties and defect chemistry of mixed conducting oxides used as electrodes in solid oxide cells. The key focus lies on the properties that are decisive for electrochemical energy conversion at high temperature: surface kinetics for O2 reduction and H2O/CO2 splitting, as well as ionic and electronic conductivity[1]. During the runtime of the "Christian Doppler Laboratory for metal supported electrochemical energy converters" (2016 - 2020), the corresponding experiments were conducted on various types of thin film and porous GDC and Ni-GDC composite electrodes which led to new mechanistic insights[2,3] and an impressive performance increase of metal supported SOFCs[4]. These investigations are now being continued in the project "Ceria-based Cathodes for High Performance Electrolysis Cells", led by Prof. Alexander Opitz, where Andreas plays an advisory role, due to his extensive experience on the electrochemical[2,5] and surface chemical properties of Ceria-based materials[6].

He is highly experienced in several experimental techniques, such as ambient pressure XPS[7,8] and XAS, SIMS[9], XRD[10], TGA, and Raman spectroscopy – all combined with in-situ electrochemical characterization. The major part of these investigations was carried out on model systems with an appropriate degree of simplification, which allows controlled and known stoichiometry, morphology and oxygen chemical potential. Nonetheless, these model cells are almost chemically identical to technologically used catalysts and electrodes. Here, vapor deposited thin-film electrodes have proven to be an excellent workhorse[7]. In the long-term, his research aims to identify the exact mechanisms of surface redox reactions and, and mixed

ion/electron conduction that allow knowledge-based optimization of oxides for catalytic and electrochemical purposes.

Most relevant other achievements

1. Allocation of € 340.000 of funding by the Austrian science fund (FWF) for the investigation of the cation defect chemistry of perovskite-type oxide electrocatalysts

2. Co-supervision of 6 master theses and 2 PhD students at TU Vienna

3. The electrochemical model for porous electrode kinetics was used for the optimization of SOFC anodes in collaboration with Plansee SE, and AVL List GmbH.

4. Worked on the development of electrochemical CO_2 sensors in collaboration with industrial partner SENSIRION.

Most relevant publications

1. Nenning, A.; Opitz, A.K.; Huber, T.M.; Fleig, J. A Novel Approach for Analyzing Electrochemical Properties of Mixed Conducting Solid Oxide Fuel Cell Anode Materials by Impedance Spectroscopy. *Phys Chem Chem Phys* **2014**, *16*, 22321–22336, https://doi.org/10.1039/C4CP02467B.
2. Nenning, A.; Bischof, C.; Fleig, J.; Bram, M.; Opitz, A.K. The Relation of Microstructure, Materials Properties and Impedance of SOFC Electrodes: A Case Study of Ni/GDC Anodes. *Energies* **2020**, *13*, 987, https://doi.org/10.3390/en13040987.
3. Nenning, A.; Gerstl, M.; Bram, M.; Opitz, A.K. Mechanistic Insight into Porous Electrode Impedance: An Example of Ni+YSZ Cermet Anodes. *ECS Trans.* **2019**, *91*, 479–490, https://doi.org/10.1149/09101.0479ecst.
4. Udomsilp, D.; Rechberger, J.; Neubauer, R.; Bischof, C.; Thaler, F.; Schafbauer, W.; Menzler, N.H.; de Haart, L.G.J.; Nenning, A.; Opitz, A.K.; Guillon, O.; Bram, M. Metal-Supported Solid Oxide Fuel Cells with Exceptionally High Power Density for Range Extender Systems. *Cell Reports Physical Science* **2020**, 100072, https://doi.org/10.1016/j.xcrp.2020.100072.
5. Nenning, A.; Holzmann, M.; Fleig, J.; K. Opitz, A. Excellent Kinetics of Single-Phase Gd-Doped Ceria Fuel Electrodes in Solid Oxide Cells. *Materials Advances* **2021**, *2*, 5422–5431, https://doi.org/10.1039/D1MA00202C.
6. Schmitt, R.; Nenning, A.; Kraynis, O.; Korobko, R.; I. Frenkel, A.; Lubomirsky, I.; M. Haile, S.; M. Rupp, J.L. A Review of Defect Structure and Chemistry in Ceria and Its Solid Solutions. *Chemical Society Reviews* **2020**, *49*, 554–592, https://doi.org/10.1039/C9CS00588A.
7. Nenning, A.; Opitz, A.K.; Rameshan, C.; Rameshan, R.; Blume, R.; Hävecker, M.; Knop-Gericke, A.; Rupprechter, G.; Klötzer, B.; Fleig, J. Ambient Pressure XPS Study of Mixed Conducting Perovskite-Type SOFC Cathode and Anode Materials under Well-Defined Electrochemical Polarization. *J. Phys. Chem. C* **2016**, *120*, 1461–1471, https://doi.org/10.1021/acs.jpcc.5b08596.
8. Nenning, A.; Reuter, S.; Schlesinger, R.; Summerer, H.; Ramehsan, R.; Lindenthal, L.; Holzmann, M.; Huber, T.M.; Rameshan, C.; Fleig, J.; Opitz, A.K. Surface and Defect Chemistry of Porous La0.6Sr0.4FeO3 Electrodes on Polarized Three-Electrode Cells. *J. Electrochem. Soc.* **2022**, *169*, 094508, https://doi.org/10.1149/1945-7111/ac908b.
9. Nenning, A.; Navickas, E.; Hutter, H.; Fleig, J. Water-Induced Decoupling of Tracer and Electrochemical Oxygen Exchange Kinetics on Mixed Conducting Electrodes. *The journal of physical chemistry letters* **2016**, *7*, 2826–2831, https://doi.org/10.1021/acs.jpclett.6b00778.
10. Opitz, A.K.; Nenning, A.; Vonk, V.; Volkov, S.; Bertram, F.; Summerer, H.; Schwarz, S.; Steiger-Thirsfeld, A.; Bernardi, J.; Stierle, A.; Fleig, J. Understanding Electrochemical Switchability of Perovskite-Type Exsolution Catalysts. *Nature Communications* **2020**, *11*, 4801, https://doi.org/10.1038/s41467-020-18563-w.