

22nd International Conference on
Solid State Ionics

Program Book

평창  2019
SSI
Solid State Ionics

June 16(Sun)-21(Fri), 2019
PyeongChang Alpensia Resort, Korea





PROGRAM DETAILS

[Day 1]

[Day 2]

[Day 3]

[Day 4]

[Day 5]

[Day 6]

June 16 (Sun)

June 17 (Mon)

June 18 (Tue)

June 19 (Wed)

June 20 (Thu)

June 21 (Fri)

11:00-12:40 | Convention Center 2F, Forest Hall

SO10 | Solid Oxide Fuel Cells and Electrolyzers (SOEC III)

Session Chair : Jongsup Hong (Yonsei University, Korea) / Sang Kyu Kang (KIMM, Korea)

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|-------------|---------|--------|--|
| 11:00-11:20 | Invited | SO-055 | Ji Haeng Yu (Korea Institute of Energy Research, Korea) Proton conducting oxide electrolyte for application to fuel cells |
| 11:20-11:40 | Invited | SO-056 | Steven McIntosh (Lehigh University, U.S.A.) Linking Bulk and Surface in MIEC materials utilizing Neutron Diffraction and High-Sensitivity Low Energy Ion Scattering |
| 11:40-11:55 | Oral | SO-057 | Ranran Peng (University of Science and Technology of China, China) Hexagonal perovskite structure transformed to cubic perovskite structure of $\text{SrCoO}_{3-\delta}$ by means of anion F-doping and obtained excellent OER electrochemical properties |
| 11:55-12:10 | Oral | SO-058 | Federico Baiutti (IREC, Spain) Thin-film nanostructuring for electrode application in solid oxide cell microdevices |
| 12:10-12:25 | Oral | SO-059 | Aleksey Yaremchenko (CICECO - Aveiro Institute of Materials, University of Aveiro, Portugal) Praseodymia-infiltrated LnNiO_3 -based oxygen electrodes for solid oxide cells |
| 12:25-12:40 | Oral | SO-060 | Vincent Thoréton (University of Oslo, Norway) Enhanced oxygen diffusion in polycrystalline $\text{La}_{0.6}\text{Sr}_{0.4}\text{Co}_{0.2}\text{Fe}_{0.8}\text{O}_{3-\delta}$ in humid oxygen |

11:00-12:00 | Convention Center 2F, Lake Hall

BA10 | Electrodes and Solid Electrolytes for Batteries (All solid state Li battery_7)

Session Chair : Yan Yao (University of Houston, U.S.A.)

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|-------------|------|--------|--|
| 11:00-11:15 | Oral | BA-047 | Zachary Hood (Massachusetts Institute of Technology, U.S.A.) Wet Chemical Processing of Lithium Garnets: Previous Challenges, A New "Solution" |
| 11:15-11:30 | Oral | BA-048 | Yuntong Zhu (Massachusetts Institute of Technology, U.S.A.) Crystallization Kinetics and Temperature-Time-Transformation-Conductivity (TTTC) Diagrams for Li-Garnet from Amorphous to Crystalline Conductive Phases |
| 11:30-11:45 | Oral | BA-049 | Jae Chul Kim (Stevens Institute of Technology, U.S.A.) Interphase Engineering for Solid-State Batteries by Additive-Assisted Low-Temperature Densification |
| 11:45-12:00 | Oral | BA-050 | Xin Guo (Huazhong University of Science & Technology, China) Ion Transport in Lithium-Ion Conducting Solid Electrolytes: Oxides and Composites |

PrO_x-infiltrated LnNiO₃-based oxygen electrodes for solid oxide cells

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Abstract

Ln₂NiO_{4+δ} and its derivatives with perovskite-related K₂NiF₄-type structure demonstrate high mixed ionic-electronic conductivity, moderate thermal and negligible chemical expansion. As a result, these phases attracted significant attention as prospective cathode materials for intermediate-temperature solid oxide fuel cells (IT-SOFC). At the same time, perovskite-like LnNiO₃ have not been considered for these applications, mostly due to the limited phase stability under ambient oxygen pressures. On heating in air, LaNiO₃ decomposes at ~ 1000°C; cathodic polarization can be expected to induce the decomposition of perovskite phase at lower temperatures characteristic for IT-SOFC operation. On the contrary, redox changes imposed by anodic polarization (in solid oxide electrolysis cell mode) under oxidizing conditions should not be of risk for the phase stability of LaNiO₃. The goal of the present work was the evaluation of LnNiO₃-based oxygen electrodes for solid oxide fuel/electrolysis cells.

The LnNiO_{3-δ} ceramic powders with perovskite-like structure was prepared by glycine-nitrate combustion synthesis followed by calcinations in oxygen atmosphere at 800-1000°C. Porous ceramic samples for electrical and dilatometric studies were sintered in oxygen at 950-1050°C.

Porous LaNiO_{3-δ} samples were found to exhibit favorably high *p*-type metallic-like electrical conductivity, 400-500 S/cm at 800-600°C in air. These ceramics demonstrated also a moderate thermal expansion, with average CTE ~ 13.0 ppm/K at 25-800°C, ensuring thermomechanical compatibility with solid electrolytes.

As a first step, the electrochemical performance of LaNiO_{3-δ} electrodes was assessed in contact with three common electrolytes including (ZrO₂)_{0.92}(Y₂O₃)_{0.08} (8YSZ), Ce_{0.9}Gd_{0.1}O_{2-δ} (CGO10) and (La_{0.8}Sr_{0.2})_{0.98}Ga_{0.8}Mg_{0.2}O_{3-δ} (LSGM). The electrode layers were sintered at 1050°C for 2 h under oxygen flow. The studies of symmetrical cells by EIS demonstrated that the electrochemical activity of LaNiO_{3-δ} electrodes increases in the sequence 8YSZ < CGO10 < LSGM; the corresponding values of electrode polarization resistance (R_η) at 800°C were 1.4, 0.8 and 0.25 Ohm×cm², respectively. Significant variations of R_η with electrolyte composition correlate with the extent of chemical reactivity between LaNiO_{3-δ} and electrolyte materials during the electrode fabrication.

The R_η values of LaNiO_{3-δ} electrodes in contact with LSGM electrolyte were further reduced to 0.03 Ohm×cm² at 800°C and 0.11 Ohm×cm² at 700°C by the surface modification with PrO_x which is known for its electrocatalytic activity. At 750°C and current density of 0.5 A/cm², LaNiO₃+PrO_x (~20 wt.%) electrodes in contact with LSGM solid electrolyte demonstrate the overpotentials of ~60 mV under cathodic polarization and ~40 mV under anodic polarization.

The impact of substitution of lanthanum by praseodymium (in order to improve the chemical compatibility and electrochemical activity) on the relevant properties of LnNiO₃ is briefly discussed.