cbecimat26
26° Congresso Brasileiro de Engenharia e Ciência dos Materiais
22 a 26 de novembro de 2026
Costão do Santinho
Florianópolis-SC

Approaches to recycling spent solid oxide fuel and electrolysis cells

Aleksey Yaremchenko, Diogo Sousa, Aleksandr Bamburov, Francielly Cesconeto

CICECO – Aveiro Institute of Materials, Department of Materials and Ceramic Engineering, University of Aveiro, 3810-193 Aveiro, Portugal

universidade de aveiro
theoria poiesis praxis
CICECO
Aveiro Institute of Materials
University of Aveiro
Lab of Solid State Ionics & Energy Conversion

www.ciceco.ua.pt
ayaremchenko@ua.pt

Introduction

The growing demand for sustainable materials in advanced electrochemical energy-conversion technologies, such as high-temperature solid oxide fuel and electrolysis cells (SOFCs/SOECs), highlights the urgent need for efficient and scalable recycling strategies. Nickel-based cermets constitute a major component of state-of-the-art anode-supported solid oxide fuel/electrolysis cells. Nickel is a critical raw material listed by the EU and its global demand is projected to increase by over 40-60% by 2030. In this context, the development of effective recovery, recycling, and reuse pathways for nickel is essential to support circular economy principles, reduce dependence on primary raw materials, and enhance the long-term sustainability of advanced electrochemical energy systems.

The present work addresses approaches for nickel recovery and reuse from end-of-life cells.

Project

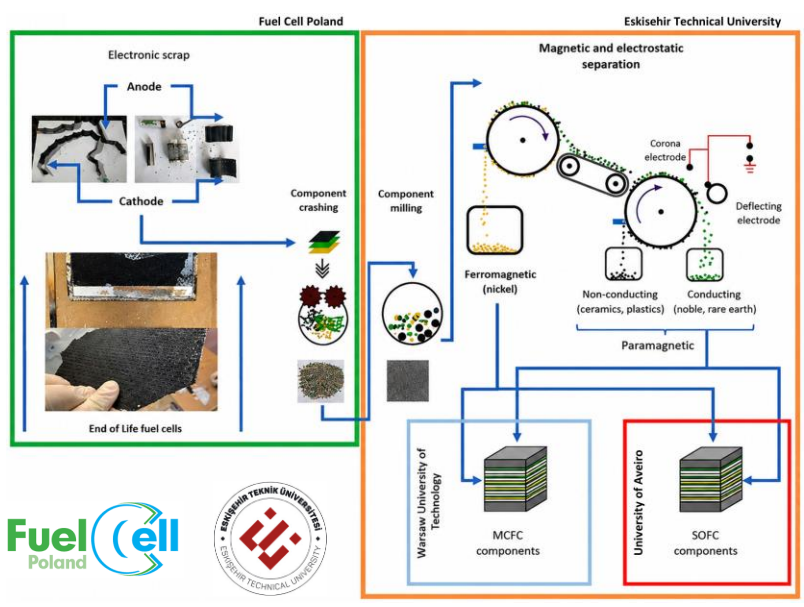
CLEARNESS: Circular product design applied to the recovery of critical raw elements from electrolyzers and fuel cells at their end of life

ERA-MIN 3
Raw Materials for the Sustainable Development and the Circular Economy

PROJECT ID

Programme: ERA-MIN3
Start date: 06/06/2024
Duration: 36 months
Funding: NCBR (Poland)
FCT (Portugal)
TUBITAK (Turkey)

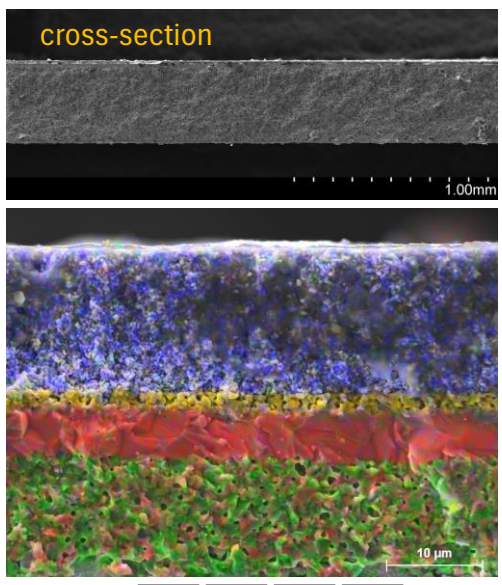
PARTNERS:



Ni/YSZ recovery from SOFC/SOEC

Spent planar SOFC/SOEC





Co Ce Zr Ni

Breaking in pieces

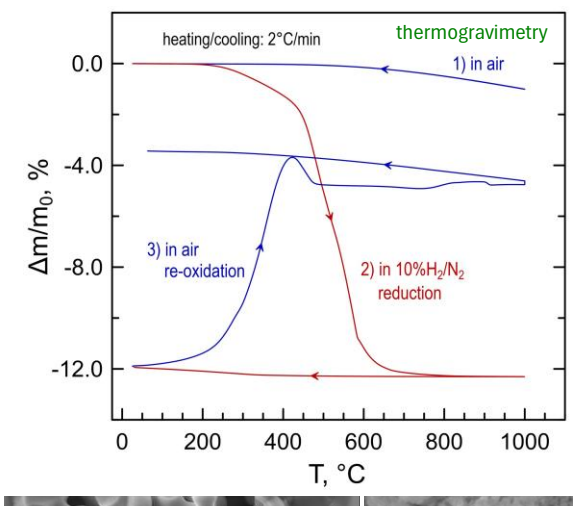
Redox thermal cycles:
1) 10%H_2, 900°C, 30 min, 2°C/min
2) air, 500°C 30 min, 5°C/min
3) 10%H_2, 900°C, 30 min, 2°C/min
4) air, 500°C 30 min, 5°C/min
5) 10%H_2, 900°C, 30 min, 2°C/min

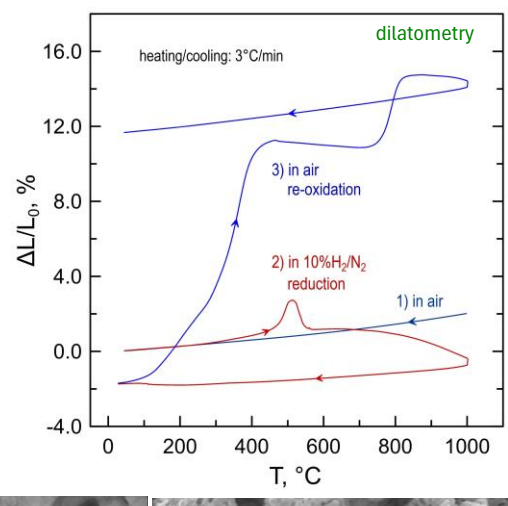
Brushing off cathode → *cathode precursor*

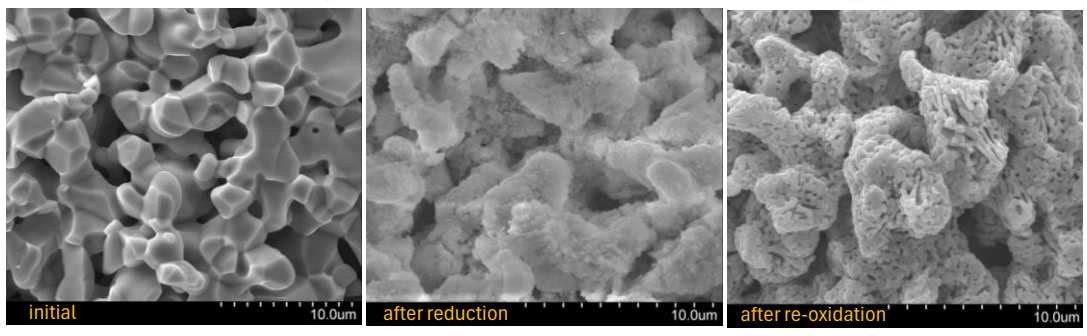
Grinding

Ball milling (600 rpm, 2h) → *anode material*

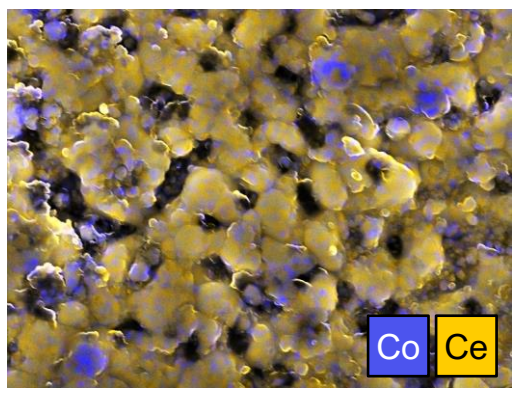
Cathode material $La_{0.6}Sr_{0.4}CoO_{3-\delta}$: redox cycling





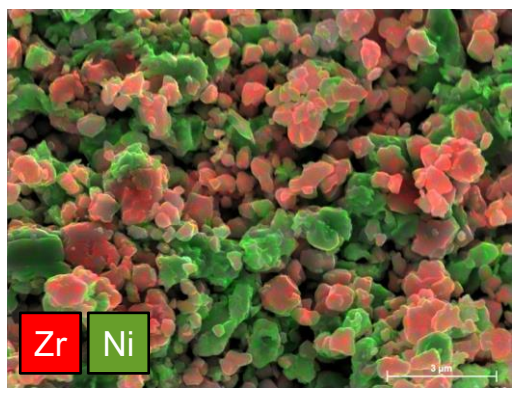


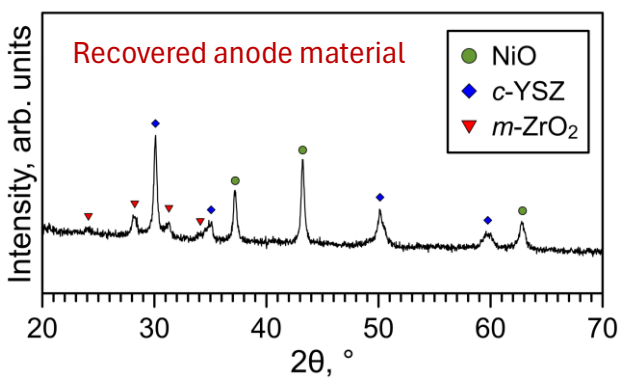
Cathode-side surface after brushing off exfoliated cathode:



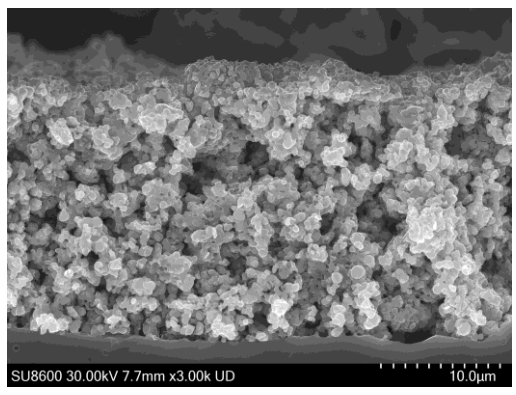
Ni/YSZ composite fabricated from the recycled material:

Measured σ ≈ 5800 S/cm at 800°C in 10%H_2/N_2





Ni/YSZ electrode (recovered material) on YSZ electrolyte:



Acknowledgements

Thanks to the partners from the Institute of Power Engineering – National Research Institute (Warsaw, Poland) for providing samples of spent SOFCs.

Funding

project CLEARNESS (ERA-MIN3/0005/2023) funded by the FCT within the ERA-MIN3 European Network

ERA-MIN 3

project CICECO - Aveiro Institute of Materials (UID/50011/2025, LA/P/0006/2020, UID/PRR/50011/2025) funded by the FCT/MCTES

fct Fundação para a Ciência e a Tecnologia
PORTUGAL 2030
UNIÃO EUROPEIA Fundos Europeus Estruturais e de Investimento