ECP 2025 Conference

The 4th International Electronic Conference on Processes

20–22 October 2025 | Online

MDPI

High-Performance Nanosized Co/rGO Composite an Efficient Oxygen Electrode Material

Ana Nastasić[1], Kristina Radinović[2], Lazar Rakočević[1], Stevan Stojadinović[3], Dalibor Stanković[1,4], Biljana Šljukić[2,5] and Jadranka Milikić[2,*]

[1] University of Belgrade, "VINČA" Institute of Nuclear Sciences - National Institute of the Republic of Serbia, Mike Petrovića Alasa 12-14, 11000, Belgrade, Serbia

[2] University of Belgrade, Faculty of Physical Chemistry, Studentski trg 12-16, 11158 Belgrade, Serbia

[3]University of Belgrade, Faculty of Physics, Studentski trg 12-16, 11000, Belgrade, Serbia

[4]University of Belgrade, Faculty of Chemistry, Studentski trg 12-16, 11158, Belgrade, Serbia

[5]Center of Physics and Engineering of Advanced Materials, Laboratory for Physics of Materials and Emerging Technologies, Chemical Engineering Department, Instituto Superior Tècnico, Universidade de Lisboa, 1049-001 Lisbon, Portugal

**jadranka@ffh.bg.ac.rs*

MOTIVATION

In the last few decades, investigations of low-cost, stable, highly active, and fast-synthesizing electrocatalysts for the oxygen evolution and reduction reaction (OER and ORR) have been the main focus of electrochemical examinations. These two reactions are key half-reactions in rechargeable metal-air batteries (MABs) and unitized regenerative fuel cells (URFCs), which are considered eco-friendly and promising energy storage technologies.

URFCs can function in two modes: in electrolysis mode, water is split into hydrogen and oxygen via the hydrogen evolution reaction (HER) and OER; in fuel cell mode, hydrogen and oxygen are used to generate electricity and water through the hydrogen oxidation reaction (HOR) and ORR. Similarly, MABs rely on OER and ORR as the primary reactions occurring at the air cathode during charging and discharging cycles. Although noble metal-based catalysts such as iridium or ruthenium oxides (IrO_2/RuO_2) and platinum (Pt) are regarded as standard electrocatalysts for OER and ORR, their use is limited by sluggish kinetics when applied in the opposite reaction—Pt for OER and IrO_2/RuO_2 for ORR.

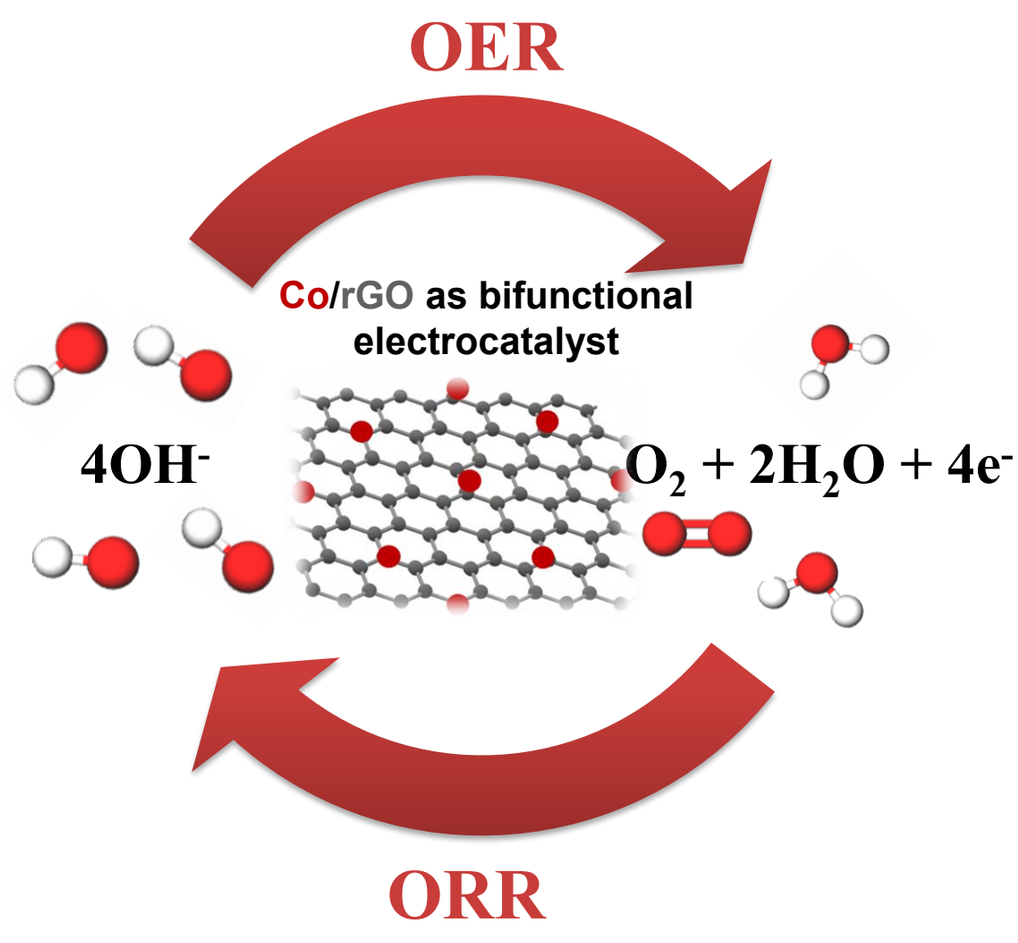

Illustration 1. Co/rGO as bifunctional oxygen electrocatalyst in alkaline media

EXPERIMENTAL

In this work, Co/rGO was synthesized via chemical synthesis, characterized by scanning electron microscopy (SEM) (**Figure 1**) and transmission electron microscopy (TEM) (**Figure 2**), as well as tested for OER/ORR in alkaline media (**Figure 3**).

RESULTS & DISCUSSION

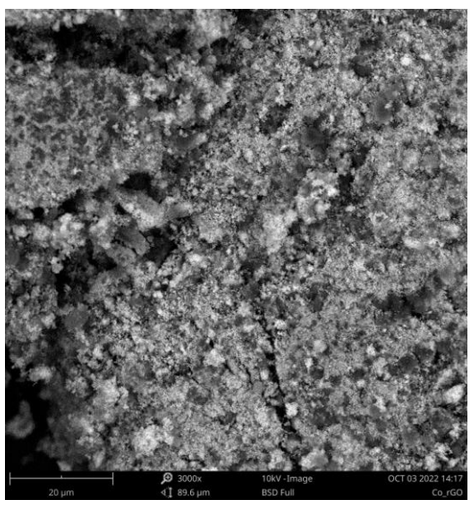

Figure 1. SEM image of Co/rGO

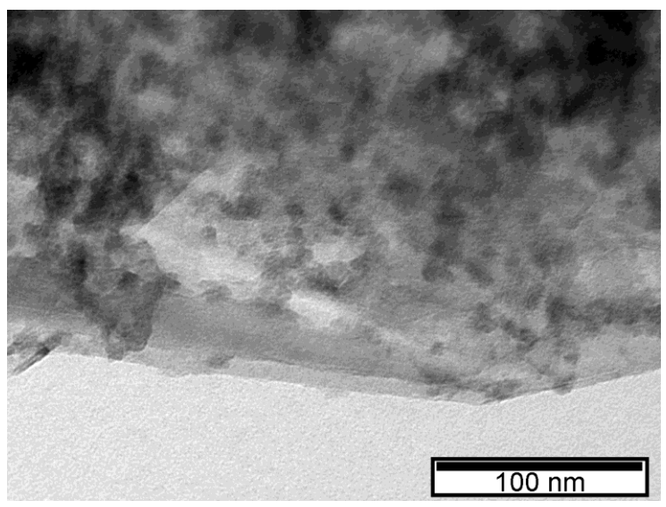

Figure 2. TEM image of Co/rGO

- SEM and TEM images confirmed that the Co/rGO morphology consists of rGO layers decorated with metallic Co nanoparticles.
- The Co/rGO catalyst exhibited a high OER current density of 174.8 mA cm^{-2} at 2 V, along with an onset potential of 1.61 V. In addition, for the ORR, the tested Co/rGO showed an onset potential of 0.84 V and a half-wave potential of 0.70 V.

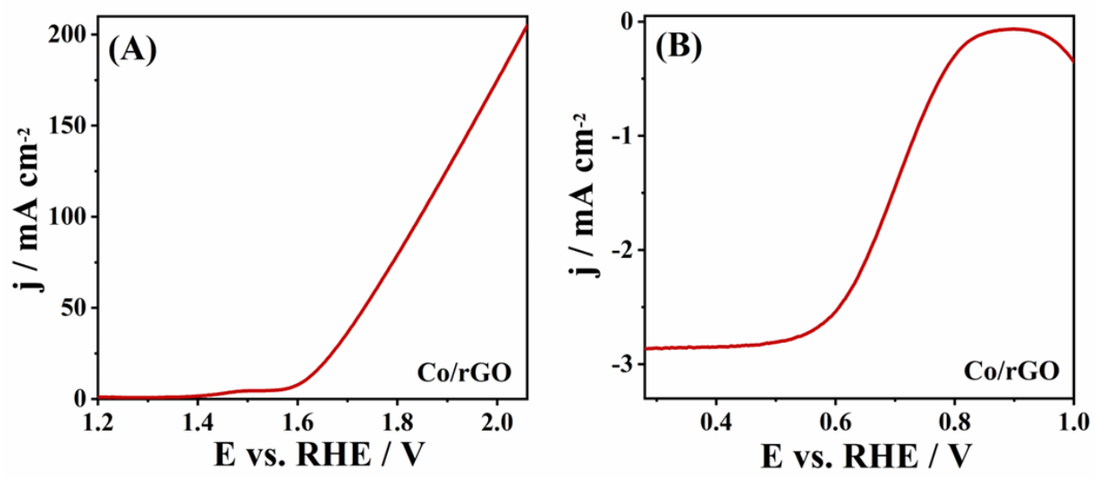

Figure 3. The IR-corrected OER polarization curve of Co/rGO in 1 M KOH (A); LSV RDE curve of Co/rGO at 1800 rpm in O_2- saturated 1 M KOH solution (B) at a scan rate of 5 mV s^{-1}

CONCLUSION

The Co/rGO electrodes demonstrated comparable or superior performance to state-of-the-art OER/ORR catalysts, with enhanced stability and cost-effectiveness, highlighting their potential as practical alternatives in metal-air batteries and fuel cells.

ACKNOWLEDGMENTS

The authors acknowledge the financial support from the Science Fund of the Republic of Serbia, grant number 250, High-performance NANosize Oxygen Electrodes: transition metals deposited ON reduced graphene oxide vs. high-entropy alloy alternatives-NANO-E-ON (Diaspora: Support for Visits of Diaspora Scientists programme).