Graphene Oxide/Cobalt-based Nanohybrids as Alternative Electrodes for Hydrogen Generation

Fabiola Navarro-Pardo†‡
Xin Tong,‡ Xin Tong,†,‡ Ana C. Tavares,‡ Haiguang Zhao,‡ Zhiming M. Wang† and Federico Rosei†,‡
†*Institute of Fundamental and Frontier Sciences, University of Electronic Science and Technology of China, Chengdu, 610054, P.R. China*
‡*Centre for Energy, Materials and Telecommunications, Institut National de la Recherche Scientifique, 1650 Boulevard Lionel-Boulet, Varennes, Québec J3X 1S2, Canada*
fabiola.navarro@inrs.emt.ca

Abstract
Low-cost nanostructured hybrid materials and optimization of structural designs are key to meet the goal of achieving high performance and stable renewable energy devices.[1,2] We have developed cobalt-based nanohybrids (CoNHs) directly electrospun onto carbon fiber paper and we demonstrate their application as electrodes for hydrogen (H_2) generation. We focused in the performance of these CoNHs in Na_2S/Na_2SO_3 electrolyte (pH=13) due to its wide application in photocatalysis and photoelectrochemical (PEC) devices.[2] These type of alternative electrodes are relevant to overcome the inherent poisoning of platinum in this sulfur containing electrolyte. We demonstrate that addition of ~12wt% graphene oxide (GO) within the CoNHs can lower the overpotential needed to maintain current densities (J) of -10 mA·cm^{-2} in a 20%, compared to the pristine CoNHs (p/CoNHs). This is corroborated by the decreased charge transfer resistance from 4.4 Ω to 2.5 Ω for p/CoNHs and the optimized GO/CoNHs, respectively. Furthermore, the CoNHs display outstanding electrochemical long-term stability, for over 42 h. Structural characterization of the as-prepared CoNHs indicate they are composed of Co_3O_4 nanoparticles (size ~10nm) conformed into one-dimensional nanoribbons. During continuous operation, the CoNHs self-assemble and regenerate in-situ into nanosheets leading to a formation of a mixture of cobalt sulfides (Co_3S_4 and CoS_2). Moreover, integration of the as-prepared CoNHs in a quantum-dot (QD) based PEC cell and an alkaline electrolyzer (1M KOH) demonstrate the generality and viability of these alternative electrodes toward active and solar-driven fuel generation.

References

[1] Tachibana, Y.; Vayssieres, L.; Durrant, J. R., *Nat. Photonics* 2012, 6 (8), 511-518.
[2] Navarro-Pardo, F.;Zhao, H. G.; Wang, Z. M.; Rosei, F., *Acc. Chem. Res*. 2018, 51 (3).

Figures

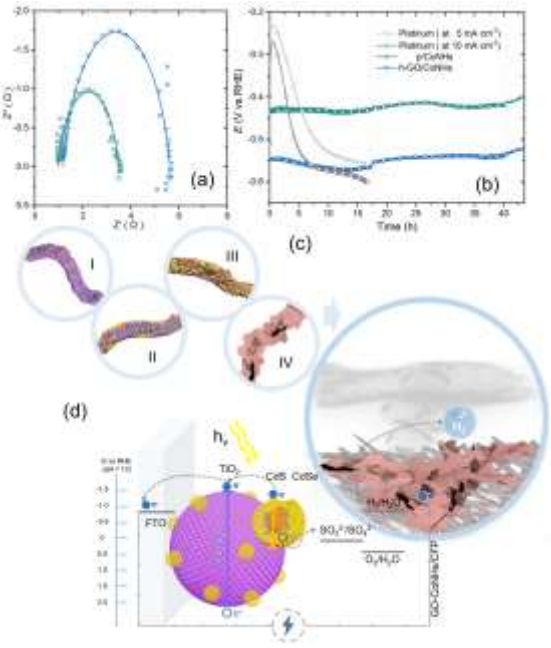

Figure 1: Nyquist plots obtained at the HER potential (−450 mV vs RHE) (e) Long-term stability measurements of the CoNHs to maintain J= -10 mA·cm^{-2} and performance degradation of the platinum electrode at different J.Scheme showing the (c) in-situ rebuilding of Co-nanoribbons into nanosheets and (d)QD-based photoelectrochemical generation of H_2.