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Editorial

Top 10 Cited Papers in the Section "Electrocatalysis"

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This editorial is dealing with the most cited papers published in the years 2018–2019 in the section "Electrocatalysis" of the journal *Catalysts*. They are mainly review papers, but regular research articles and communications are also present in this analysis. The main topics appear related to the reactions/processes occurring in fuel cells and electrolysers, i.e., oxygen reduction, oxygen evolution, hydrogen evolution, hydrogen oxidation, with the only exception being a paper dealing with electrochemical sensing performance toward dopamine.

The paper collecting the highest number of citations is a review paper of H. Zhong et al. [1], which analyzes the advances in the development of cobalt-based catalytic centers as the most potentially useful alternatives to noble metal-based electrocatalysts (Pt-, Ir-, and Ru-based) towards the oxygen reduction reaction (ORR), oxygen evolution reaction (OER), and hydrogen evolution reaction (HER) in acid and alkaline media. The Co-based catalysts are categorized into five groups, namely, cobalt chalcogenides (selenides, sulfides), cobalt oxides, Co–LDH, Co–MOFs, and Co–N_x/C. Synthetic strategies, structural properties, defects, and support materials are discussed as a function of the electrocatalytic performance of cobalt-based electrocatalysts, together with the perspectives for large-scale application of these materials.

Another review paper dealing with electrocatalysis for the oxygen reduction reaction (ORR) [2] received great attention due to the important application in fuel cells and metal–air batteries. The high cost of noble metal hinders the commercialization of the above-mentioned devices. Therefore, developing efficient and cost-effective catalysts is of vital importance. This work summarizes the recent progress of nitrogen (N)-doped metal-free catalysts for the ORR and provides future perspectives for their further development.

The effect of metal doping on Ni-based electrocatalysts for hydrogen oxidation was investigated by E. S. Davydova et al. [3]. Ni–TM/C (where TM stands for the doping elements Fe, Co, and Cu) electrocatalytic composites were synthesized via the chemical reduction method, and physico-chemically characterized by using different techniques. The electrochemical properties towards hydrogen oxidation reaction in alkaline medium were studied using the rotating disc electrode and cycling voltammetry methods, revealing a significant role of the TM dopants in the promotion of the hydrogen electrooxidation kinetics of the binary Ni–TM/C materials.

Another review paper analyzes the ORR, but in this case it summarizes the efforts employing Pt, Au, Ag, Pd and Ru clusters, as well as the alloyed bi-metallic clusters for acquiring highly efficient catalysts to enhance both the activity and stability [4]. The current challenges, the future outlook, and the perspectives will be proposed, featuring the great opportunities and potentials to engineering noble metal clusters as highly efficient and durable cathodic catalysts for fuel cell applications.

Only one article in this top-10 list of most cited papers is not dealing with reactions/processes occurring in electrochemical energy conversion and storage devices. In this work, the morphology-dependent electrochemical sensing properties of MnO_2-reduced graphene oxide/glass carbon electrode (MnO_2-RGO/GCE) toward dopamine detection were investigated [5]. Different morphologies of nanoscale MnO_2 were synthesized under different hydrothermal conditions. Successively, the MnO_2-

RGO/GCEs were fabricated and analyzed. MnO_2 nanowires (NWs)-RGO/GCE showed the best electrochemical sensing performance for dopamine detection.

In the sixth position of this ranking, there is a communication dealing with NiMo catalysts for hydrogen evolution reaction in alkaline environment, both in half-cell (rotating disc electrode) and anion exchange membrane electrolysis cell configurations [6]. An electrolyser performance of 1 A cm^{-2} at 1.9 V (total cell voltage) with a NiMo loading of 5 mg cm^{-2} and an iridium black anode in 1 M KOH at 50 °C was demonstrated, close to the performance reached with a Pt catalyst at the cathode.

Another topic of special interest regards the bifunctional behavior for oxygen reduction and evolution reactions in alkaline media of $NiFeO_x$ nanomaterials [7]. The samples were mostly in layered double hydroxide at the initial temperature, but upon heat treatment, they were converted to $NiFe_2O_4$ phases. The electrochemical behavior of the different samples was studied by linear sweep voltammetry and cyclic voltammetry on the glassy carbon electrode. The sample heat-treated at 250 °C delivered the highest bifunctional oxygen evolution and reduction reaction activity (OER/ORR) thanks to its thin-holey nanosheet-like structure with higher nickel oxidation state at 250 °C. This work gives new insights to help in developing low-cost electrocatalysts for metal–air batteries.

A short review paper highlights some of the research works undertaken over the years by Pollet's research groups in Birmingham, Cape Town, and Trondheim, in the use of power ultrasound for the fabrication of low temperature fuel cell and electrolyser catalysts and electrodes [8]. The attraction of power ultrasound is the ability to create localized transient high temperatures and pressures, as a result of cavitation, in solutions at room temperature.

In the ninth position, we find a paper entitled "Carbon-Supported Copper-Based Nitrogen-Containing Supramolecule as an Efficient Oxygen Reduction Reaction Catalyst in Neutral Medium" by Y. Zhao et al. [9]. In this work, a nitrogen-containing bidentate ligand was synthesized as a nitrogen precursor for making an oxygen reduction catalyst. The nitrogen group provided a coordination site for copper ions, and the resulting Cu-N_x material was dispersed on the surface of Vulcan XC-72 carbon and used as a catalyst for the ORR. The latter reaction was achieved mainly via a four-electron transfer process to water, which confirms that this catalyst might have potential application as a cathode in microbial fuel cells, which operate in an aqueous medium.

In the tenth position there are two papers receiving the same citations, one dealing with oxygen reduction (ORR) and hydrogen evolution (HER) reactions catalyzed by Pd–Ru nanoparticles encapsulated in porous carbon nanosheets [10], while a comprehensive overview of the developments of ternary and quaternary 6d-group transition metal chalcogenides (TMCs) based electrocatalysts for water splitting, especially for HER, is presented in the other one [11].

From this analysis, we can derive that the hot topics are surely the processes occurring in electrochemical energy storage devices, mainly fuel cells, electrolysers, and metal-air batteries, in particular the oxygen related reactions (ORR and OER) and hydrogen production (HER).

I hope that the journal readers enjoy this editorial and the highly cited papers summarized here.

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