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On-site production of hydrogen peroxide in electrocatalysis and in heterogeneous catalysis

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Hydrogen peroxide (H_2O_2) is an important green chemical oxidant, commonly used for disinfection, bleaching and water treatment. It is currently produced in large centralized reactors through the so-called anthraquinone process. Considering that most of the end-use applications require concentrations around 2 to 5 wt%, an on-site continuous production of H_2O_2 at low concentration is desirable. Both the electrochemical reduction of oxygen (ORR) to hydrogen peroxide and the direct synthesis in an autoclave could provide a more efficient alternative to the current industrial process. Despite the state of the art characterization techniques, being applied to determine the surface structure of mono and bimetallic catalysts, there is still a lack of detailed understanding of the active sites of the metal nanoparticle and the actual reaction mechanism. In this work, different molar ratio of Au/Pd catalysts were synthesized with a final metal loading of 10 wt% on activated carbon and the influence of bimetallic nanoparticles composition for oxygen reduction reaction (ORR) and hydrogen oxidation reaction (HOR) is studied. The change in activity, selectivity towards H_2O_2 as well as in H_2O_2 decomposition is characterized in both an electrochemical cell (electrochemical synthesis), using a rotating ring disk electrode (RRDE), and in an autoclave (heterogeneous direct synthesis). While the addition of Au to Pd increases the overall selectivity, the results showed the lowest H_2O_2 productivity for pure Au during direct synthesis and the same catalyst showed the highest peroxide current in the electrochemical cell (Figure 1). This difference has been characterized and a mechanism for the H_2O_2 synthesis in the direct synthesis will be proposed.

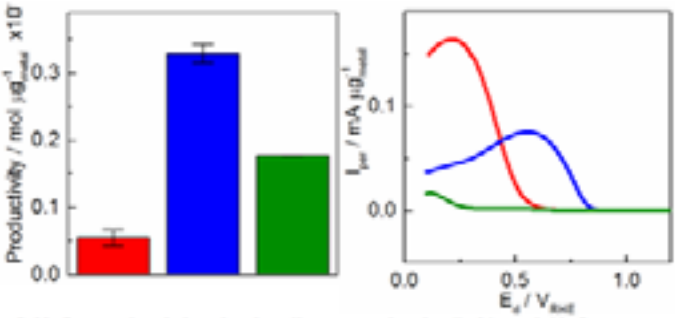

Fig.1 H_2O_2 productivity in the direct synthesis (left) and H_2O_2 current in an electrochemical RRDE cell (right)

Biography

Enrico Pizzutilo is a PhD student in the Electrocatalysis Group of Professor Dr. Karl Mayrhofer at the Max-Planck Institute for Iron Research. His expertise and interest are electrocatalyst for fuel cell and electrolyzer application as key technologies for solving the current energy storage problem. The current work has been elaborated in collaboration with the group of Graham Hutchings at the Cardiff Catalysis Institute, where he spent part of his PhD.

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