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Electrocatalytic properties of metal hydroxy-phosphonoacetate derivatives for OER, ORR and HER

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Abstract: Although Pt and Ru/Ir-based noble metal materials are the state-of-the-art electrocatalysts for energy storage and conversion, their applications are still limited by their scarcity and high price. Therefore, the design of low-cost and efficient electrocatalysts is highly desired and full of challenge [1].

Herein we report the electrochemical properties of several metal phosphonates derived from the reaction of (R,S)-2-hydroxyphosphonoacetic acid (HPAA) with transition metals (M = Fe^{2+}, Co^{2+}, Mn^{2+}, Ni^{2+}), including their corresponding solid solutions. By pyrolytic treatment under N_2 or 5% H_2/Ar, materials having a wide range of compositions (phosphate, pyrophosphate, phosphides…) have been prepared and their electrochemical properties tested for OER and ORR and HER. Pyrolyzing in N_2 at 500 °C, led to amorphous pyrophosphates, with Fe^{2+}/Co^{2+} solid solutions displaying the lowest overpotential for the OER, whereas the Mn^{2+} derivative showed the best performance for the ORR. At higher temperature, pyrolyzed materials were crystalline pyrophosphates (N_2) or metal phosphides (H_2-Ar). In general, the latter compounds displayed better performances for the HER, Ni_2P being the most active electrocatalyst. Addition of reduced graphene oxide (rGO) significantly improved the behaviour of the electrocatalysts for OER and ORR.

Key words: Coordination polymers, metal phosphonates, electrocatalysts, oxygen evolution reaction, oxygen reduction reaction, hydrogen evolution reaction, reduced graphene oxide.

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