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Lecture Title: "Hydrogen production by ethanol-assisted electrolysis on board of vehicles for their electric propulsion"

Abstract:

Hydrogen is one of the most in demand chemicals, it is used for ammonia production to produce fertilizers, in fuel cells to generate electrical energy, or burned to directly produce energy.

Actually, the main way of producing hydrogen is through steam reforming, which involves reacting water with natural gas at high temperatures and pressures to separate water's oxygen and hydrogen atoms, but the inconvenience is the additional direct carbon dioxide emissions. Apart of this, the process is energy intensive and requires burning large amounts of fossil fuels.

On the other side, electrolytic hydrogen produced by primary renewable energy sources is free of carbon emissions, however, it shows an inherent problem, the inefficiency of producing oxygen at the anode due to the low kinetics of this reaction. Thus, it is a non-suitable way to produce hydrogen on-board of a vehicle.

These limitations can be overcome by a low cost and free-carbon emission technology of electrolytic hydrogen production assisted by alcohol oxidation, which replaces the oxygen evolution reaction. Such adapted method lowers energy costs by up to 40% and may offer a promising pathway for efficient and scalable hydrogen production on board of vehicles.

Thus, in this lecture will be described the development of catalysts for hydrogen evolution reaction (HER) and ethanol oxidation in alkaline medium (4 M KOH + 1 M ethanol at $\leq 85^\circ\text{C}$). The measurements were made in an electrochemical electrolysis cell with electrodes of 25 cm^2 . The catalysts were characterized by XRD, Raman spectroscopy, HRTEM and SEM. Tested materials for hydrogen: (i) MoS_2 and (ii) Ni/B intermetallic compounds. The MoS_2 was obtained by electrodeposition from $(\text{NH}_4)_2\text{MoS}_4$ precursor on black pearls high area carbon matrix doped with nitrogen. The activity of MoS_2 for the HER is similar to the Pt electrode and was not sensitive for ethanol reduction. The synthesis method used for preparation of Ni/B intermetallic were grinding the metallic components in a ball mill and heat treated under inert argon atmosphere according to the phase diagram. The Ni_2B intermetallic showed an improvement for the HER.

Finally, a proof-of-concept demonstration of a model vehicle operated by hydrogen generated with the assistance of ethanol will be presented.