MAX phases as the catalysts support materials for green energy related applications

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ABSTRACT

MAX phases – specific materials of general formula Mn+1AXn, (MAX) where n = 1 to 4, where M is early transition metal, A is element from the group of Al, Si or P and X is carbon or nitrogen, have attracted great attention in materials science, especially as high performance supports for noble metals group catalysts intended to be used for hydrogen production by water electrolysis, as well as for fuel cells reactions. These materials demonstrated good mechanical properties, high conductivity, high chemical and corrosion stability, especially in the potential range from hydrogen to oxygen evolution that is of great interest for low temperature fuel cells reactions. In this research ultra- low loading platinum layers were deposited onto Ti2AlC and (Nb-Ti)2AlC MAX phases supports and characterized as the catalysts for anode (hydrogen oxidation) and cathode (oxygen reduction) reactions for low temperature fuel cells. Physical-chemical characterization was performed by: Scanning Electron Microscopy (SEM), X-Ray Photoelectron Spectroscopy (XPS), Focus-Ion Beam High Resolution Transmission Electron Microscopy (FIB-HRTEM). The electrochemical characterization for both anode and cathode reactions was done by cyclic voltammetry and linear sweep voltammetry and very good activities were confirmed in comparison to carbon supported commercial catalysts. It should be emphasized that progress beyond state of the art was made in terms of lower Pt loading - being only 18.3 μg cm-2 (for HOR the state of the art is ≈ 50 μg cm-2, while for ORR 200 -400 μg cm-2). These novel catalysts exhibited high durability according to US DOE standardized tests, as well. It is worthy to mention that the support materials are low cost and electrodeposition, as well.
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Keywords: Fuel cells; MAX phases; ORR and HOR catalysts; low Pt loading layers;

Biography: Dr Nevenka R. Elezovic completed her PhD in 2005, from University of Belgrade. She is currently Research Professor at the Institute for Multidisciplinary Research, University of Belgrade. Her research interests include: Nanostructured materials and alloys for low temperature fuel cells and water electrolysis application - green energy production. Since 2013 she has been serving as representative of Serbia and member of the European board in European Academy of Surface Technology,http://www.east-site.net. She has published more than 40 papers in reputed peer reviewed journals of eminent Publishers such as Elsevier, Royal Society of Chemistry, The Electrochemical Society and more than 70 conference papers. She has been serving as a reviewer for: Energy and Environmental Science, Applied Materials and Interfaces, Journal of Materials Chemistry A, Electrochimica Acta, Applied Catalysis B: Environmental, RSC Advances, Journal of the Electrochemical Society, International Journal of Hydrogen Energy, as well as adjudicative (senior) reviewer for Energy and Environmental Science and Journal of Materials Chemistry A. She has given numerous invited lectures at the International conferences, recently at International Summit on Conventional and Sustainable Energies, March 30-31, 2018 Orlando, Florida, USA; Global Experts Meeting on Frontiers in Green Energy and Expo, October 14-16, 2019 Rome, Italy; Materials, the Building Block for the Future 3rd AAAFM-UCLA conference, August 18-20 2021 Los Angeles USA; Euro-Global Climate Change Conference, September 19-20, 2022 Paris, France.