Effect of hydrothermal conditions on the physicochemical properties of Cu-Ce oxide nanostructures

George Avgouropoulos*
Department of Materials Science, University of Patras, GR-26504 Rio, Greece
Joan Papavasiliou
FORTH/ICE-HT, GR-26504 Platani, Patras, Greece

The development of efficient and low-cost nanomaterials for fuel cell energy systems has attracted huge research attention during the last decade [1-7]. Polymer Electrolyte Membrane Fuel Cells (PEMFCs) which operate with pure H_2 appear to be an ideal energy solution for portable and mobile energy applications. In order to avoid several technical and safety limitations concerning the use of pure H_2, the utilization a H_2-rich gas mixture is favored. This gas mixture can be produced from hydrocarbons or alcohols (natural gas, gasoline, methanol) as a H_2 carrier, through a catalytic fuel processor. The starting fuel is converted in a H_2-rich gas through a catalytic processor. However, the produced reformate gas contains a significant concentration of carbon monoxide (ca. 1% CO), thus needing further purification, since this amount of CO poisons the anode electrocatalysts of low temperature PEM fuel cell. Preferential catalytic CO oxidation (PROX reaction) is a simple and cost-effective method for removing CO to less than 20 ppm from reformed fuels. Cu-Ce mixed oxides have been prepared with different methods (impregnation, co-precipitation, sol-gel, combustion) and proposed for the title process [3]. Recent years, the research community employs new chemical synthesis methods, aiming to the preparation of nanostructured catalysts with high selectivity, extremely high activity, low energy demands and long life time [4]. These can be achieved only by controlling the size, the shape, the particle size distribution, the composition and the electronic structure of the surface, the thermal and chemical stability of the specific nanocomponents.

In this work hydrothermal method was employed, using citric acid as chelating agent, sodium hydroxide as precipitating agent and copper nitrate and cerium nitrate as copper and cerium precursors, respectively. Synthesis parameters of CuCeOx catalysts were temperature and duration of hydrothermal process, and sodium hydroxide concentration. Choosing proper combination of these parameters, different nanostructures (rods, cubes, polyhedra, spheres) can be obtained, with attractive physicochemical characteristics. Activity and selectivity of nanostructured catalysts were tested for CO preferential oxidation in the presence of excess H_2.

References

[1] M. Kipnis, Appl. Catal. B **152-153**, 38 (2014).
[2] K. Liu, A. Wang, T. Zhang, ACS Catalysis **2**, 1165 (2012).
[3] G. Avgouropoulos, T. Ioannides, Chem. Eng. J. **176-177**, 14 (2011).
[4] R. Si, M. Flytzani-Stephanopoulos, Angew. Chem. Int. Ed. **47**, 2884 (2008).

* geoavg@upatras.gr