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Synthesis, Thermal evolution and Catalytic Properties of Pt-Pd-O Thin Films

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The use of electrochemistry, especially the Electrochemical Promotion Of Catalysis (EPOC) is an expanding domain to activate and control a reaction process. This approach consists in applying an electrical potential between electrode-catalyst and counter-electrode films deposited on both sides of a dense ionic-conductor. One of the requirements for the use of EPOC phenomena to industrial processes, like methane combustion, is the thermal ageing resistance of the electrode-catalyst coating. Unfortunately, a covering metallic thin film evolves at high temperature in isolated agglomerates inhibiting the application of EPOC. The deposition of PdO, an active oxide catalyst, represents an alternative technology due to its thermal inertia up to 700°C.

In the present study, Pt-Pd-O films have been deposited by the reactive pulsed filtered cathodic arc (FCA) technique onto silicon and yttria-stabilized zirconia (YSZ) substrates. This method is potentially very valuable to the deposition of noble metal oxides due the high ion energy and level of activation of the condensing species. The pulse repetition rate of the two metal cathodes was used to control the composition ratio and stoichiometry of the ternary noble metal oxide films.

The catalytic activity of the synthesized Pt-Pd-O films was compared against that of Pt, PtO2 and PdO films. The thermal evolution of these films was investigated by scanning electron microscopy (SEM) and X-ray diffraction (XRD). The amorphous PtO_2 film is reduced in crystalline metallic platinum between 450°C and 500°C. PdO crystallizes during the annealing treatment and resists reduction up to 700°C. These two compounds can be used to tune the morphology and keep the percolating character of PdO in Pd-Pt-O films. In the meantime, the compositions of these films allow us to take advantage of the catalytic properties of PdO and Pt. The interest of the thermal resistance are tested for the methane combustion reaction (CH_4/O_2 = 2000 ppm/10%) on YSZ/Pd, YSZ/PdO_{2+x}, YSZ/Pd-Pt-O catalysts.

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