**Partial oxidation, steam reforming and autothermal reforming of ethanol over Pt/Ce\(_{0.75}\)Zr\(_{0.25}\)O\(_2\) catalyst**

S. M. de Lima\(^1\), A. M. Silva\(^1\), L. V. Mattos\(^1\) and F. B. Noronha\(^1\)*

*Instituto Nacional de Tecnologia (INT) Laboratório de Catálise, sala 518, Av. Venezuela 82, CEP 20081-310, Rio de Janeiro, (Brazil)\
*fabiobel@int.gov.br

**Introduction**

The use of H\(_2\) to generate electric power through fuel cell is one of the most promising technologies that can contribute to the reduction of global dependence on fossil fuels, of greenhouse gas emissions and of atmospheric pollution. Recently, ethanol has been claimed as the best source of H\(_2\) production for fuel cells since it can be manufactured from biomass and does not contribute to CO\(_2\) emissions. Moreover, in countries like Brazil and USA, the ethanol production and distribution infrastructure was already established. Hydrogen can be produced from ethanol by steam reforming, partial oxidation and autothermal reforming. However, the routes for production of hydrogen from ethanol involve a complex reaction system [1]. Several reaction pathways take place depending on the catalysts and reaction conditions. Some of these reactions lead to the formation of by-products, which can affect the efficiency of fuel cells, and to the catalyst deactivation. Recently, we have investigated the performance of supported Pt catalysts on partial oxidation of ethanol [2,3]. Pt/CeO\(_2\) and Pt/CeZrO\(_2\) catalysts revealed to be the best catalysts for fuel processors to PEM fuel cell based on the partial oxidation of ethanol since they exhibited good stability and activity on this reaction. The good performance of these materials was attributed to its high oxygen storage capacity. The aim of this work is to compare the performance of Pt/CeZrO\(_2\) catalyst on the steam reforming (SR), partial oxidation (POX) and autothermal reforming of ethanol (ATR).

**Materials and Methods**

Ce\(_{0.75}\)Zr\(_{0.25}\)O\(_2\) support was synthesized following the coprecipitation method reported by Mattos et al [3]. The support was calcined at 1073 K for 1 h, Pt (1.5 wt.%) was added to the support by incipient wetness impregnation with an aqueous solution containing H\(_2\)PtCl\(_6\)\(6\)H\(_2\)O. The catalysts were characterized by BET surface area, X-ray diffraction and oxygen storage capacity (OSC). The Pt dispersion was measured by the cyclohexane dehydrogenation reaction. The reactions were performed in a fixed bed reactor at atmospheric pressure. Prior to reaction, the catalysts were reduced at 773 K for 1 h. The reactions were carried out at 773 K and W/Q = 0.02 g-s\(^c\)m\(^2\). It was used H\(_2\)/ethanol molar ratio = 2.0 (for SR and ATR) and O\(_2\)/ethanol molar ratio = 0.5 (for POX and ATR). The exit gases were analyzed on line using a chromatograph equipped with thermal conductivity detector.

**Results and Discussion**

The BET surface area of Pt/Ce\(_{0.75}\)Zr\(_{0.25}\)O\(_2\) catalyst was 34 m\(^2\)/g. The X-ray diffraction patterns of Ce\(_{0.75}\)Zr\(_{0.25}\)O\(_2\) support showed that the zirconia was incorporated into the CeO\(_2\) lattice and a solid solution with cubic symmetry was formed. The OSC value of Pt/Ce\(_{0.75}\)Zr\(_{0.25}\)O\(_2\) catalyst was very high (626 \(\text{mmol/g-cat}\)). This is attributed to the high mobility of the solid solution formed, which was identified by the XRD data. The Pt dispersion was 22%. For POX and ATR reactions, the initial ethanol conversions were similar and they were higher than that observed for SR reaction (Figure 1a). The activity strongly decreased at the beginning of the SR reaction, but the catalyst became practically stable after 2 h time on stream (TOS). In the case of POX reaction, the catalyst was stable after an initial period of deactivation. However, for ATR reaction, the catalyst exhibited a continuous deactivation during 6 h TOS. These results showed that the increase of O\(_2\) amounts in the feed favored the stability of the catalyst. The H\(_2\) production on SR followed the same trend as ethanol conversion. For POX reaction, the H\(_2\) formation was very low and it was no longer detected after 1 h TOS. The catalyst produced large amounts of H\(_2\) during 6 h TOS on ATR reaction.

**Figure 1.** (a) Ethanol conversion (full symbols) and H\(_2\) molar composition (open symbols) vs. reaction time; (b) products distribution obtained at the same conversion in dry basis.

**Significance**

The aim of this work is to develop a catalyst to H\(_2\) production from ethanol for fuel processors to PEM fuel cell.

**References**