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CH₄ conversion into value-added products by catalytic processes assisted by electrochemical reactions in solid oxide cells

Vanessa B. Vilela^{1,2}, Vivian V. Thyssen³, Daniel Z. de Florio⁴, Andres S. Ferlauto⁴, Marlu C. Steil², Fabio C. Fonseca¹

¹Nuclear and Energy Research Institute, IPEN-CNEN, 05508-000, São Paulo, SP, Brazil, ²Univ. Grenoble Alpes, Univ. Savoie Mont Blanc, CNRS, LEPMI, Grenoble INP (Institute of Engineering and Management), 38000, Grenoble, France, ³Innovation SENAI Institute for Biomass, ISI Biomassa, 79640-250, Três Lagoas, MS, Brazil ⁴Center for Engineering, Modeling and Applied Social Sciences, Federal University of ABC, 09210-580, Santo André, SP, Brazil

e-mail: fabiocf@usp.br

Methane (CH₄), the major constituent of natural gas and biogas, is an abundant source to obtain value-added hydrocarbons. The oxidative coupling of methane (OCM) is a direct catalytic route to convert CH₄ towards C₂ hydrocarbons (C₂H₆ and C₂H₄). The use of electrochemical devices such as solid oxide fuel cells (SOFC) as a reactor for OCM is possible, providing synergistic control of electrochemical oxidation/reduction reactions to energy production with in-situ catalysis [1]. In this context, the use of mixed oxide La_{0.5}Ce_{0.5}O_{2-δ} (LCO) was studied as an additional catalytic layer on the Ni/YSZ anode of a SOFC for the operation under CH₄ as fuel. The presence of surface oxygen vacancies in single-phase LCO, which may benefit the OCM reaction, was evidenced by Raman spectroscopy [2]. The catalytic properties of LCO at 800 °C were investigated in a fixed-bed catalytic reactor, resulting in a C₂ selectivity and yield of 41% and 8%, respectively. The modified SOFC with the additional LCO-catalytic layer was fabricated and tested under H₂ and CH₄ [2]. The electrochemical properties were studied during online gas analysis of the anode outlet. The experimental data revealed that CH₄ conversion and product distribution are closely related to operational conditions such as reactant concentration, anode feed flow rate, current output, and operating temperature. In addition to C₂, products of internal methane reforming (CO and H₂) were detected in all evaluated conditions. The SOFC showed stable behavior, maintaining a stable current of 20 mA·cm⁻², 10% of CH₄ conversion, and 14% of C₂ selectivity throughout 30 h. The combined catalytic and electrochemical reactions described are considered a promising approach to producing valuable chemicals and electrical energy.

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