

Plasma aided Nitric oxide synthesis: electrocatalysis vs catalysis

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Abstract:

Nitrogen fixation is unquestionably one of the most important chemical processes because it converts atmospheric nitrogen and other elements into a fundamental component of the production of many chemicals such as ammonia, nitrates, and many other daily usage products [1]. For example, nitric oxide, one of the nitrogen fixed compound, is commercially utilized as an intermediate for the formation of nitric acid (HNO_3), in fertilizer industry as well as in the manufacture of explosives, synthetic fibers, dyes, plastics and can be also used in biomedical applications [2]. However, contemporary chemical industry for nitrogen fixation impose great concerns about the environmental sustainability in terms of immense energy consumption and burdened emissions profile. In this regards, plasma-technology has been received immense attention as an alternative “green” approach for N_2 activation [3] which is one of the fundamental requirement for NO (or NH_3) synthesis. Therefore, in this work, plasma synthesis of NO has been studied in nitrogen–oxygen plasmas using two different approach; 1) first one is electrocatalysis on platinum coated 8% yttria stabilized zirconia electrochemical cell (Pt/YSZ/Pt), and 2) second one is catalysis on YSZ/Pt catalyst [4]. In both cases a radiofrequency plasma [5] was combined with the corresponding catalysts. The final product was mainly nitric oxide. We have also discussed and compared the effect of the gas composition, bulk gas temperature and plasma input power for plasma-aided electrocatalysis and catalysis both. In addition, experiments for plasma-aided electrocatalysis were carried out in two different flavours: (i) by providing oxygen from air, and (ii) by feeding oxygen from H_2O electrolysis through a solid oxide electrochemical cell (Pt/YSZ/Pt). In both cases activated nitrogen from the RF plasma led to NO synthesis.

Keywords: Nitric oxide, catalysis, electrocatalysis, radiofrequency plasma, electrolysis.

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