**High-entropy oxide catalysts with fluorite structure for ethanol dry reforming**

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Hydrogen is an appealing alternative fuel for energy storage and transportation due to its high energy content, clean combustion properties, and potential for renewable production. Among the various methods for hydrogen production, ethanol reforming stands out as a promising approach. This process converts ethanol, a renewable bio-based resource, into hydrogen, offering a sustainable pathway to meet energy demands while reducing environmental impact [1]. Series of high entropy oxides (HEO) with fluorite structure were synthesized to be tested in ethanol dry reforming (1).

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| $$C\_{2}H\_{5}OH\_{\left(g\right)}+CO\_{2\left(g\right)} ⇆ 3H\_{2\left(g\right)}+3CO\_{\left(g\right)}, Δ\_{r}H\_{298K}^{°}=296.8kJ/mol.$$ | (1) |

Ce0.2Zr0.2Hf0.2Ti0.2La0.2O2 (CZHTL), Ce0.2Zr0.2Nb0.2Ti0.2La0.2O2 (CZNTL) and Ce0.2Zr0.2Er0.2Ti0.2La0.2O2 (CZETL) were synthesized via citrate method. Catalysts containing 5 wt.% Ni were obtained by incipient wetness impregnation of the HEO with an aqueous solution of Ni(NO3)2, followed by drying and calcination at 700°C in the air. According to the XRD data, after calcination CZNTL was a mixed oxide with a cubic fluorite structure with a crystallite size of 20-30 nm, CZHTL and CZETL are less crystallized. After the deposition of nickel, the NiO phase was clearly identified. According to the TEM data of fluorites, the particles were crystallized phases of 10-20 nm, and shown that all cations were uniformly distributed in the oxide structure. The adsorption isotherms of CZHTL, CZNTL and CZETL were of type IV according to the IUPAC classification [2], which indicated that they were characteristic of mesoporous materials, with a distribution maximum of 57 nm, 34 nm and 18 nm, respectively, while for Ni/CZHTL, Ni/CZNTL and Ni/CZETL catalysts, the distribution maxima were 23.9 nm, 23.7 nm and 14 nm. The specific surface area of ​​the nanomaterials was determined by the BET method based on N2 thermal desorption for all fluorites it was approximately the same ~ 30 m2 /g CZHTL, CZNTL and CZETL and for catalysts varies from 17 to 30 m2/g. Ni- catalysts were tested in the reaction of dry reforming of ethanol (2% EtOH + 2% CO2 + Ar, contact time 10 ms). The main products were H2, CO, CO2, and CH4. With increasing temperature, the conversion of reagents and product yields were increased. The sample based on the oxide Ni/Ce0.2Zr0.2Er0.2Ti0.2La0.2O2 demonstrated the best efficiency, providing ethanol conversion already at 650°C 80% and the highest hydrogen yield 64% at 750°C. After the catalytic tests the catalysts were examined by TEM and TGA analysis, a small amount of carbon filaments was observed on the surface of the catalysts.

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**References:**

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