Nanocomposites and nanomaterials

Characterization of Co-Ni nanocomposyte supported on Al_2O_3 as CO_2 reduction catalyst

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Evolving economic activity, especially in developing countries, leads to increasing CO_2 emissions. Elevated atmospheric CO_2 concentration leads to multiple ecological problems. Hence, reducing CO_2 emissions is an extensive and long-term task [1, 2]. In principle, there are three possible strategies with this regard: reduction of the amount of CO_2 being produced, CO_2 storage and CO_2 usage as a feedstock [3]. It is impossible to decrease the CO_2 emissions by suppression of the economic activity. Global CO_2 recycling can solve this problem [4, 5].

A series of Al_2O_3 supported bimetallic Co-Ni nanocomposites with different Co/Ni ratios was synthesized. Close Co and Ni crystallic lattice parameters leads to formation isomorphically substituted crystallites with the same morphology as pure Co or Ni crystallites obtained in the same conditions have.

Catalyst preparation method was optimized to obtain fine Co-Ni bimetallic nanocomposite particles supported on Al_2O_3. It was incipient wetness impregnation of Al_2O_3 with $Co(NO_3)_2$ and $Ni(NO_3)_2$ aqueous solution mixture followed by careful moisture evaporation and gradual reduction in diluted with He (50 ml/min) H_2 (50 ml/min) flow. Samples were characterized utilizing following methods:

<u>*SEM*</u> indicates uniform metallic phase distribution on support's surface with extended superficies (fig.1). Co/Ni distribution is indiscrete according to SEM-EDS analysis.

<u>*XRD.*</u> For all samples only fcc metallic phase occurs in XRD patterns, and it could be attributed to Co-Ni alloy.

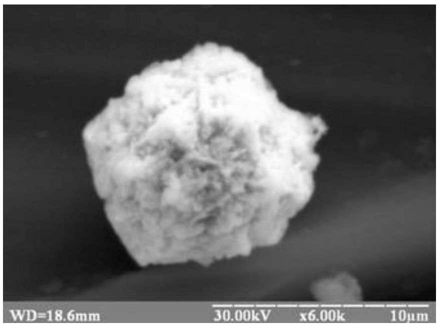

Fig.1 SEM microphotograph of $(Co_{80}Ni_{20})20\%/Al_2O_3$ sample

<u>*Catalysis.*</u> Hydrogenation of CO_2 was performed with 1.0 g of catalyst in a fixed-bed reactor. The reaction was carried out at 0,1 MPa pressure in temperature range 200°C – 400°C with step width 25°C. Feeding gas being composed of 50 ml/min He, 30 ml/min H_2 and 7,5 ml/min CO_2 (stoichiometric H_2:CO_2 = 4:1 ratio), leads to GHSV =

5250 h^{-1}.

Compared with monometallic Ni- and Co- based catalysts, the bimetallic Ni-Co catalysts showed higher methanation activity and the Ni/Co ratios significantly affected the methanation activity. The highest activity was obtained over $Co_{80}Ni_{20}/Al_2O_3$ bimetallic catalyst in lower-temperature range (200-225 °C) and over $Co_{20}Ni_{80}/Al_2O_3$ bimetallic catalyst in higher-temperature range (250-325 °C). All catalysts were investigated showed high stability during methanation reaction.

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2. *Wei Wang, Jinlong Gong* Methanation of carbon dioxide: an overview // Front. Chem. Sci. Eng.-2011.-**V.5(1)**.-P. 2–10.
3. *Robert W. Dorner, Dennis R. Hardy, Frederick W. Williams et al.* Heterogeneous catalytic CO_2 conversion to value–added hydrocarbons // Energy Environ. Sci.-2010.-**V.3**.-P. 884–890.
4. *James T. Richardson*. Improved Sabatier reactions for in situ resource utilization on Mars missions // ISSO • UHCL/UH.-1999–2000.-**V.1**.-P. 84–86.
5. *K. Hashimoto, M. Yamasaki, S. Meguro et al.* Materials for global carbon dioxide recycling // Corrosion Science.-2002.-**V.44**.-P. 371–386.