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Nio Nano- And Micro-Particles Prepared By Solvothermal Method – Good Catalysts for CO_2 Methanation.

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Extended Abstract

Burning hydrocarbons for industry, energy and transport produce large amounts of CO2, what pollutes the Earth's atmosphere [1]. For the last 300 years, the amount of CO2 in the earth's atmosphere has increased by 50% [2]. This gas negatively causes nature because of global warming, melting ice, and rising water levels in the world's oceans [3]. Progressive electricity consumption, active motorization, and the construction industry led to an increase in the CO_2 content in the atmosphere. The problem increased due to the reduction in forest area worldwide. However, in recent years, ways to solve this problem have begun to appear. The Orca factory appeared in Iceland 3 years ago, and the Mammoth factory was opened in Switzerland in this year [4,5]. Both factories use direct air capture (DAC) technology to condense excess CO_2 from the atmosphere. However, gas storage capacities will not be endless, and the question arises about the rational use of condensed gas.

CO_2-methanation seems to be a very promising process due to the relative ease of implementation and production of methane. At its core, methanation(hydrogenation) is the reverse process of combustion of methane(hydrocarbons) [6]. In the future, it will be possible to obtain a completely closed cycle - produce products by methanation(hydrogenation) and use them in energy, and the resulting carbon dioxide can be used again to produce methane (or hydrocarbons).

The synthesis of metal and metal oxides micro-(MPs) and nanoparticles (NPs) of great interest to researchers from all over the world. These substances are used in a wide variety of fields of science and technology: catalysis, sensor, high sensitivity biomolecular magnetic resonance imaging, magnetic tomography, hyperthermia of magnetic fluid, biomolecule separation, targeted drug delivery, gene delivery for medical diagnostics etc. Nickel oxide (NiO) is widely used as a catalyst for various processes of hydrogenation or reduction of organic compounds with hydrogen. Due to the greater surface activity of MPs and especially NPs of nickel oxide, this improves the catalytic properties of these substances. However, the synthesis of NiO MPs and NPs with a narrow size distribution is not the easiest process. The choice of chemical process, duration, and reaction conditions affect the size and properties of micro- and nanoparticles. In this study, the synthesis of NiO MPs and NPs was conducted using the simple solvothermal method in the atmosphere of organic solvents and high-temperature decomposition of nickel hydroxide [7]. Different morphologies (micro-spheres, sheet clusters, hexagonal micro-particles, and nano-discs) were prepared using this method with different solvents and stabilizers [7,8].

In heterogeneous catalysis, nickel oxide is used as an excellent methanation catalyst in the Fischer-Tropsch reaction (with CO) and modified Fischer-Tropsch reaction (with CO2). This study reports a modified Fischer-Tropsch reaction. However, CH_4 selectivity and CO_2 conversion strongly depend on NiO MPs and NPs shape, size, and surface area. The prepared catalysts were tested in the hydrogenation of CO_2 in a gas phase with excellent conversion values and high selectivity to produce CH_4. The best results were obtained with the NiO with disc or sphere morphology, which produced methane with selectivity at level near 100% and conversion close to 90%.

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