Ni-Fe, Co-Fe and Co-Ni nanocomposites based on carbon nanotubes in the reaction of CO_2 methanation

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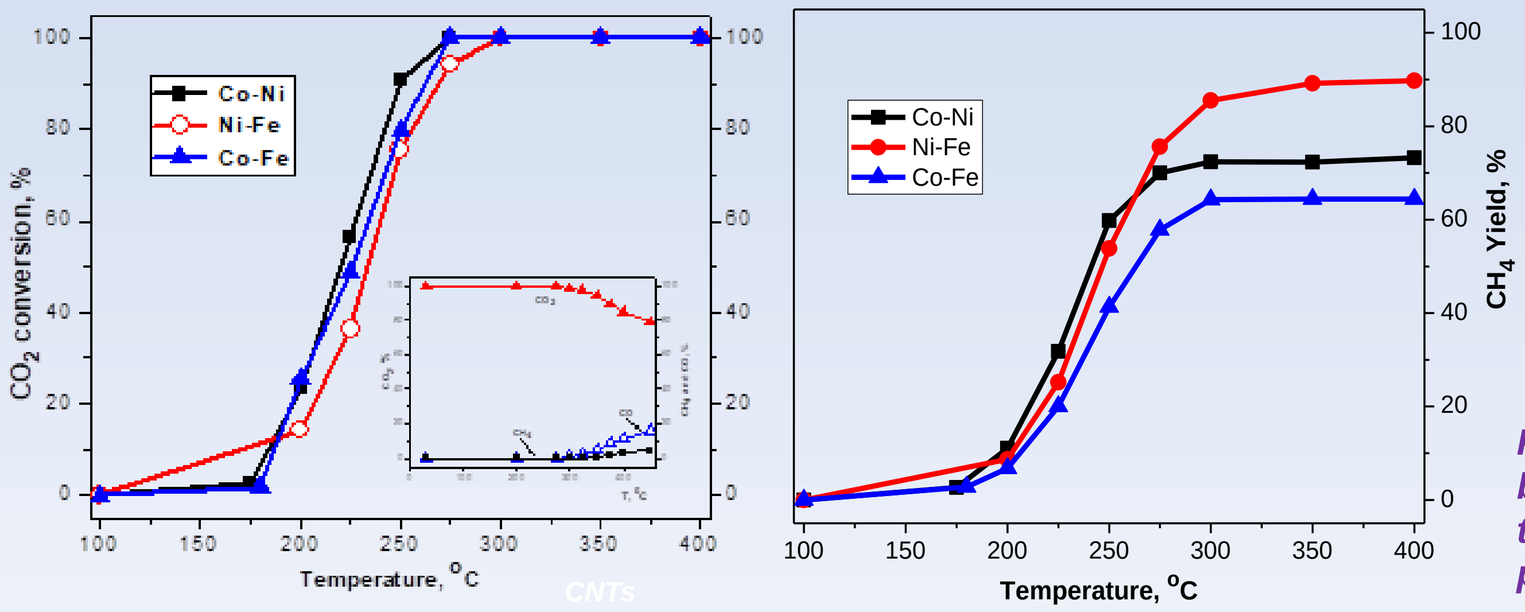
Introduction. Global warming-induced climate change is one of the significant civilization threats of the modern times. Excess greenhouse gases, 82% of which are CO_2, cause global warming. Therefore, in today's world of high-energy demands, CO_2 conversion and utilization seems to be a more attractive and promising solution. The methanation of carbon dioxide is an important catalytic process of fundamental academic interest with potential commercial application. Among the wide range of materials, bimetallic catalysts supported on carbon nanotubes occupy a special place.

Preparation of composites CNT was used as support for preparation of Ni-Co, Ni-Fe, Co-Fe catalysts. The synthesis of supported catalysts was provided by wet impregnation of carrier with nitrate solution of corresponding metals. Following the impregnation, catalysts were air dried and then treated with H_2/He gas mixture at 340 ^{0}C for 2 hours. The amount of applied active mass was 20 wt.% by weight of the carrier. Catalytic performance in the methanation process was examined with a supply of 2%CO_2–55%H_2–43%He gas mixture and chromatography controlled. The crystal structure and surface morphology of the samples after catalytic test were determined by XRD and SEM methods.



Resulting of catalytic test, we can conclude 100% conversion of CO_2 with CH_4 yield: 73% – $Co_{80}Ni_{20}$/CNT, 64% – $Co_{93}Fe_{07}$/CNT, 85% – $Ni_{80}Fe_{20}$/CNT at 300 ^{0}C and atmospheric pressure. Pristine carbon nanotubes showed a small catalytic activity in the methanation process at the high temperature (450 °C) with 21% of CO_2 conversion and yield of CH_4 – 5 %. Also CO (16 %) was detected as co-product.

Fig 1. Catalytic performance data CNTs based bimetallic nanocomposites under various reaction temperature (Result of CNTs catalytic test is presented inside figure)

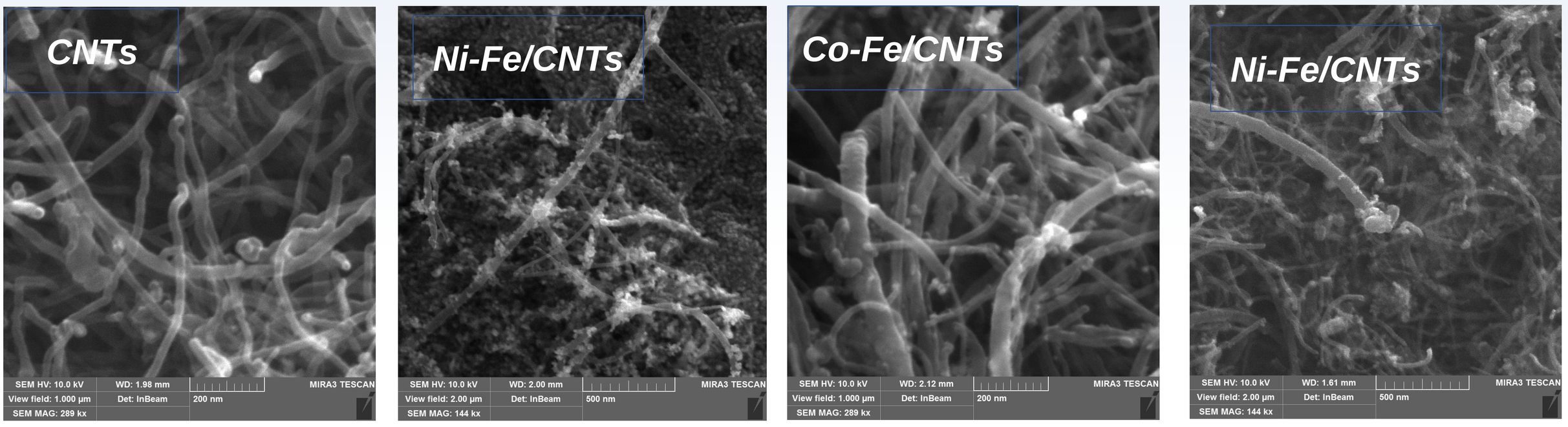


Fig. 2. SEM pictures of nanocomposites after evaluation of them in the methanation process

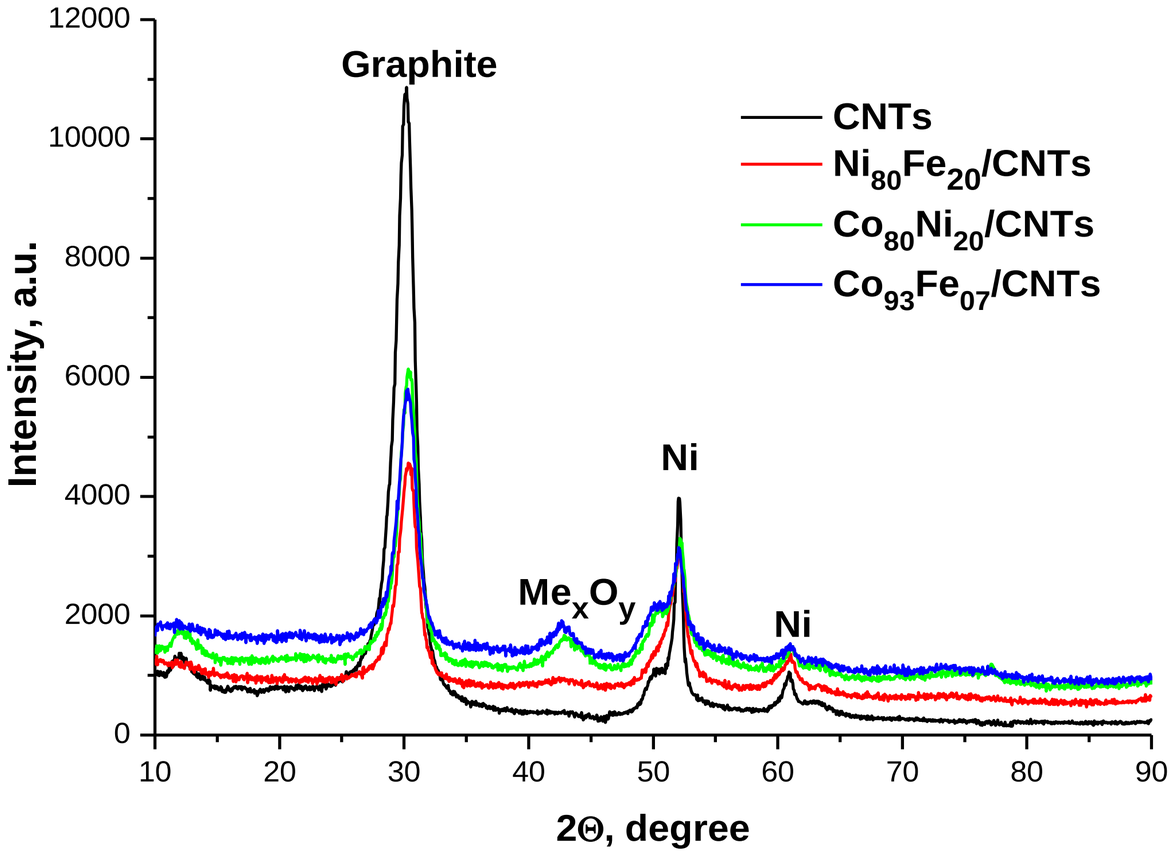


Fig.3. XRD patterns of nanocomposites compare to pristine CNTs

SEM EDX analysis of catalysts surface shows uneven distribution of actives over CNTs. The metal grains with the size in the range of 10-50 nm are located on the external surface of CNTs. XRD patterns of investigated nanocomposites have the diffraction peak at 30.2° corresponding to the graphite structure and diffraction peaks at 52.1 and 60.9 corresponding to the nickel derived from initial CNTs. Also, the reflex of metal's oxides (Co_xO_y and Fe_xO_y) was indicated.