The latest Cu-V-Mo/TiO_2 catalysts for NO_2 reduction

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Introduction

Pollution of the environment by nitrogen oxides has become one of the major problems in the world. The sources of their entry into the atmosphere are industrial emissions due to the combustion of hydrocarbons at low temperatures, combustion processes in power plants or car engines, and natural phenomena. These gases cause several environmental problems and can cause many health hazards. That is why NO_x emissions should be controlled and minimized. One of the possible nitrogen oxides reducing emissions methods is their selective catalytic reduction to nitrogen [1]. However, existing commercial catalysts have some disadvantages, such as a fairly narrow temperature range and high reduction temperature. Therefore, the development of new more efficient NO_x reduction catalysts is an urgent issue.

Based on the analysis of the authors' works [2,3], it was concluded that the combination of V_2O_5, as a standard NO_x reduction catalyst used in industry, with CuO and MoO_3 is quite promising. Prospects are explained by the high study of the V_2O_5 catalytic properties in NO_x reduction processes, the ability of CuO to increase the amount of surface adsorbed gases with enhancing the reactivity, and the ability of MoO_3 to increase catalytic activity and resistance to H_2O and SO_2.

Aim and Objectives

The main aim of this research was the synthesis of the latest Cu-V-Mo/TiO_2 catalysts for selective reduction of NO_2.

To achieve the aim was necessary to conduct a comparative analysis of existing developments of catalysts for the reduction of nitrogen oxides, to develop based on data perspective catalysts, and to carry out their synthesis and to investigate the efficiency of the obtained catalysts.

Methods

- Synthesis of catalysts samples was carried out by impregnation.
- Determination of the synthesized catalyst samples phase composition was performed by X-ray phase analysis (X-ray diffraction) on a diffractometer Rigaku Ultima IV (Japan) with CuKα radiation (40 kW, 30 mA).
- Determination of the catalysts' chemical composition was performed by X-ray fluorescence analysis on a precision analyzer EXPERT 3L, INAM (Ukraine). The device allows to analyze liquids, solids and powdered substances, the elemental composition of which is in the range from magnesium to uranium with a minimum amount of substance that can be detected 0.005%.
- Studies of the catalyst samples' surface chemistry were performed by IR - spectroscopy using a Thermo Nicolet Nexus FTIR 470 spectrometer (USA) with a Fourier transducer. The measurement is performed in the range of 4000-400 cm^{-1} (usually the resolution is 4 cm^{-1}, and the number of scans - 32).

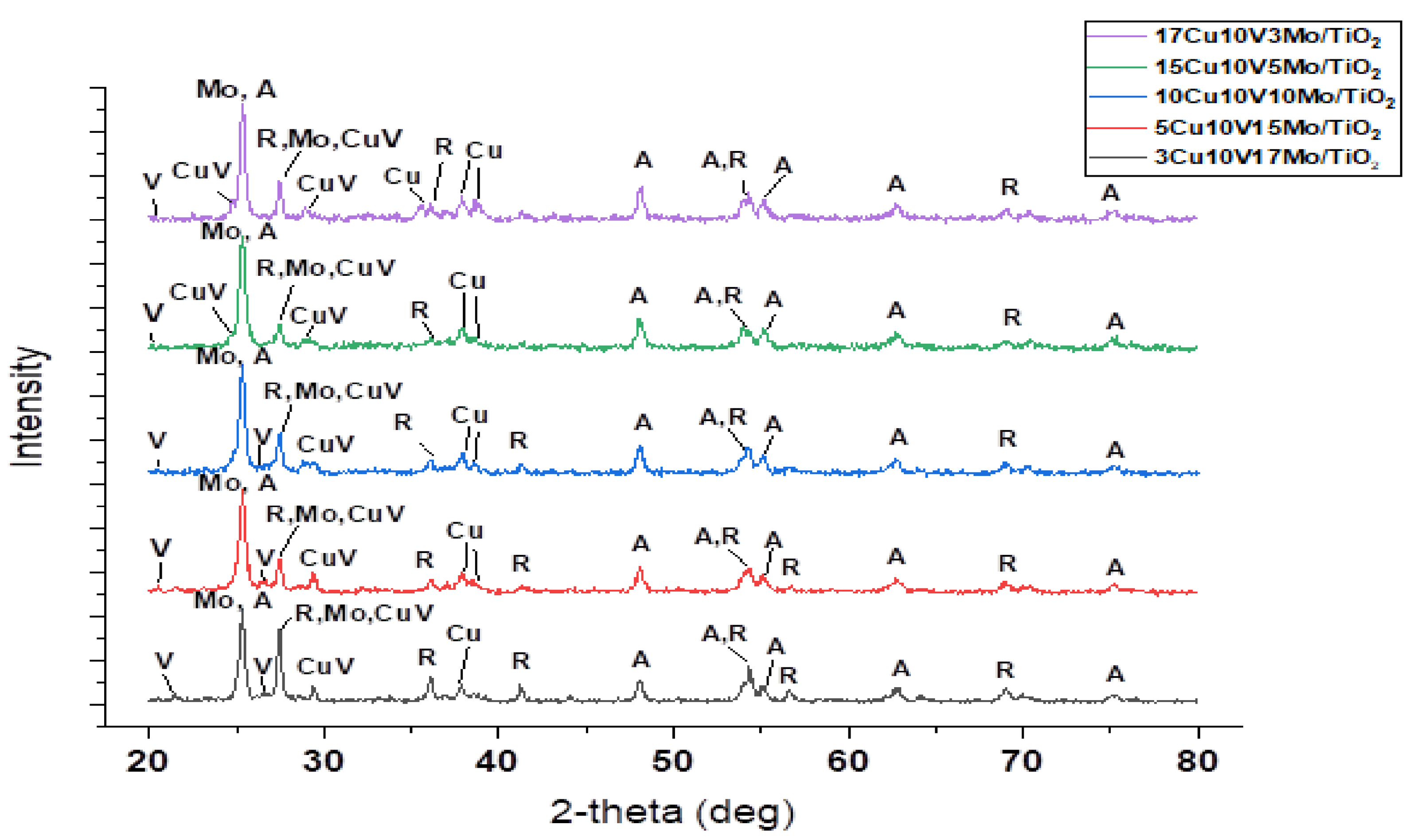

Figure 1. – Diffractograms of synthesized catalysts samples (V – vanadium (V) oxide; Mo – molybdenum (VI) oxide; Cu – copper (II) oxide; CuV – blossite; R – rutile; A – anatase)

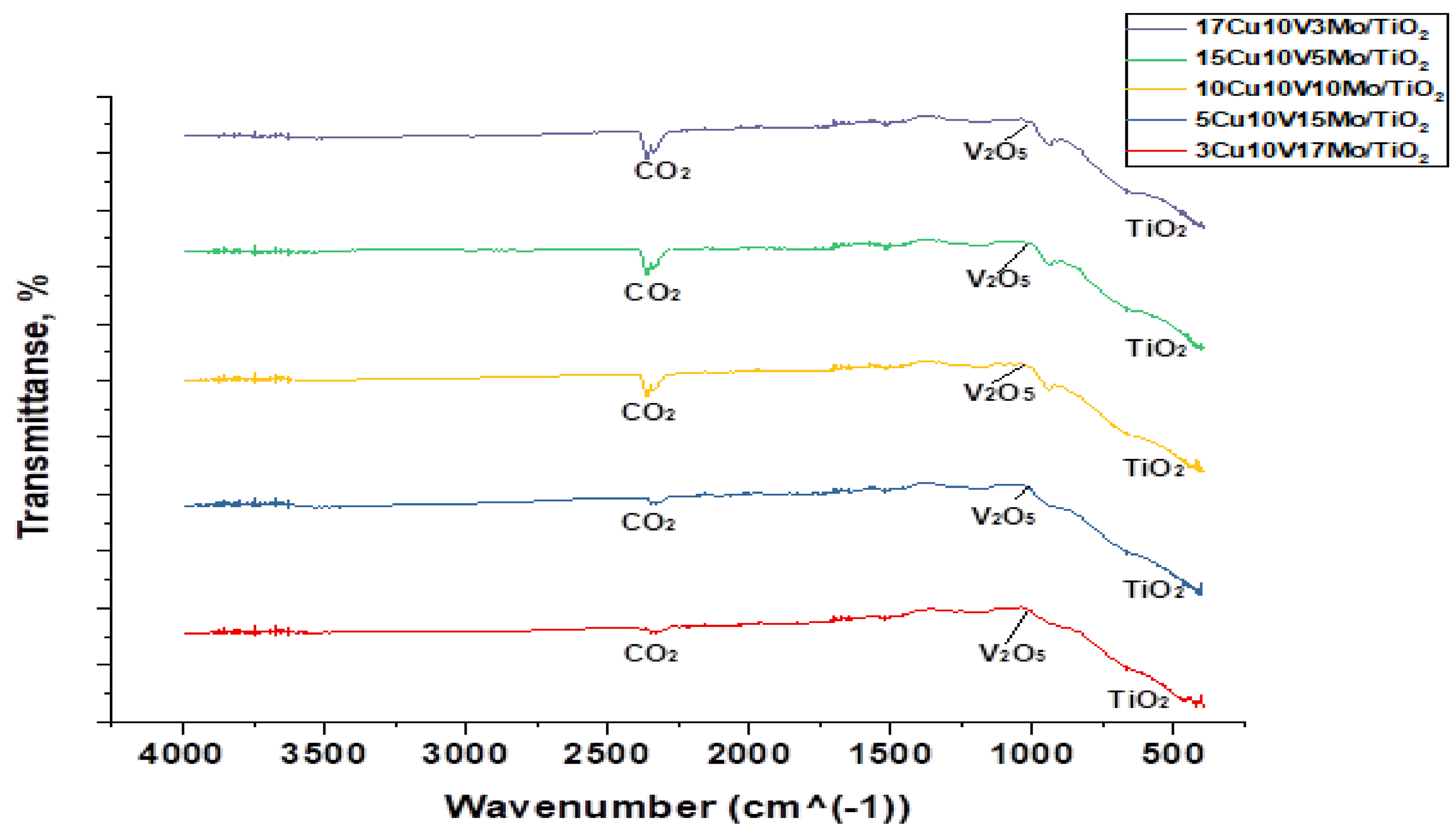

Figure 2. – Infrared spectra of synthesized catalyst samples

Results and Conclusion

In this study, several catalysts based on titanium oxide (IV) with different ratios of active components (Mo, V, Cu) were synthesized. According to the above diffractograms (Fig. 1), in addition to the phases inherent in titanium oxide (anatase, rutile), the phases molybdenum (VI) oxide, copper (II) oxide and blossite were detected. IR spectra confirm the results of diffraction research and indicate the presence of active centers of an alkaline nature (Fig. 2). The catalytic activity of the synthesized catalysts in the reactions of NO_2 reduction with its initial concentration in the gas mixture at the level of 433 ppm was revealed and characterized. In the process of catalytic selective reduction at low temperatures (100-200 °C), they showed catalytic activity, which amounted to an 80% reduction of NO_2 at 190 °C. The revealed fact gives grounds to claim that Cu-V-Mo/TiO_2 catalysts are perspective for use in processes of reduction of nitrogen oxides.

References

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