Abstract

The search for new and refined catalysts is a crucial challenge in sustainable chemistry. Particularly significant are the efforts to find new catalysts for environmental and energy engineering. The key direction in this regard is technologies that use anthropogenic carbon dioxide or reduce air pollutants, such as nitrogen oxides. In my work, I undertake research on heterogeneous catalysts for the hydrogenation of carbon dioxide to methane (CO_2 methanation) and the selective catalytic reduction of nitrogen oxides (NOx). The research aims to design and test selected new catalytic materials, active metal compositions, and the implementation of nanometals on the support surface. The subject of research is transition elements, in particular nickel and its combinations with noble metals.

In my work, I engaged in the challenges of catalysis of carbon dioxide methanation and selective catalytic reduction of nitrogen oxides. I developed new bi- and polymetallic catalysts that are a combination of Ni and Mo, Re, Ru, Rh, Pd, Pt, Au. I worked especially on the target functional form of the catalyst. I synthesized new, tenacious 3D structures made of Ni wool or Ni mesh ornamented with Re, Ru, Pd or Au nanoparticles for CO_2 methanation and plate catalysts (Re, Pd)/Ni-Mo and (Re, Pd, Ni)/V_2O_5-WO_3-TiO_2 for NOx reduction in NH3-SCR. I also did research work on powder catalysts; Ni-Mo, Re/Ni, Rh/Ni, Pt/Ni, (Re, Pd)/Ni, and (Re, Pd)/Ni-Mo, in the above-mentioned reactions. I examined the effect of induction heating of the catalyst on its activity in comparison with conventional heating from an external source. I described two methods of generating nanoparticles and presented my method of ornamentation with nanoparticles, which involves mechanically covering a selected surface with nano-paint.

The research contributes to industrial and commercial projects that use catalytic reduction of nitrogen oxides or carbon dioxide methanation. Among these projects, a system for reducing NOx from diesel exhaust and industrial emissions, a Power-to-Gas project, or the production of synthetic fuels, olefins and polymers may be given. The results also contribute to reducing the consumption of noble metals in catalysis and improving the energy consumption of catalytic systems through induction heating.