Popular scientific abstract

"Novel Hybrid Nanostructures Based on Molybdenum Disulfide and Carbon Nanomaterials for Lubricating Applications"

Molybdenum disulfide (MoS_2) is a two-dimensional layered material. Nanolayers of MoS_2 are bonded by weak van der Waals interactions, thanks to which monolayers can easily slide in relation to each other. MoS_2 is also characterized by good thermal stability and corrosion resistance. Due to its unique properties, MoS_2 finds various applications, such as dry lubricants, and nanoadditives of engine oils.

Due to the advanced designs of modern technologies used to optimize engine working conditions, such as multi-point fuel injections or engine control units require liquid lubricants with excellent tribological properties. Oil additives are primarily used to protect moving elements against wear and improve the quality of engine exhaust gases. Therefore, new and low-cost oil additives, which will meet the requirements of modern technologies, are sought.

To enhance the tribological behavior, multiple additive types of MoS_2-based materials have recently appeared. Hybrid nanostructures based on MoS_2 and carbon nanomaterials (CNMs) are especially promising. MoS_2 nanoparticles deposited on the carbon surface exhibit smaller particle sizes, narrower particle size distributions, and a lower tendency to agglomerate, resulting in better tribological properties.

In this project, a novel, scalable, low-cost, and facile method for preparing materials for lubricating applications is proposed. The main aim of this project will be the synthesis of high-quality hybrid nanostructures based on molybdenum disulfide and various carbon nanomaterials (MoS_2/CNMs), such as graphene oxide, reduced graphene oxide, carbon nanotubes, and their modifications. The synthesis of hybrid nanostructures MoS_2/CNMs will be carried out in the continuous flow reactor i.e. jet reactor. Impinging jet reactor characterized with continuous work, easy design, scalability, and production of particles with desired and repetitive properties. This technique is a novel method fully developed by a research team from the Division of Separation Processes at the Faculty of Chemical and Process Engineering. This method will be expanded as part of the project in order to produce materials with high-quality and enhanced tribological properties.

The obtained materials will be tested as oil additives. Full rheological and tribological analysis of the engine oil with the addition of MoS_2/CNMs will be performed. The influence of the used nanoadditives on the quality of exhaust gases from a real engine will also be investigated. In addition, certain technologies, including aviation and space technologies, due to their unique working conditions require the use of dry lubricants. The produced hybrid materials also have the potential to be used as dry lubricants. Hence tribological tests of the dry materials will be carried out. Various parameters will be selected in order to obtain both dry lubricant and engine oil with excellent lubricating properties. Moreover, to fully understand the tribological mechanisms of the materials and the efficiency of the synthesis, physicochemical analysis of the obtained MoS_2-based materials will be performed.

The project will result both in high-quality materials based on molybdenum disulfide with enhanced lubricating properties and in a novel and facile technology of their production. The interdisciplinary character of this project will connect science fields, such as chemical and process engineering and nanotechnology, which will provide the development of the best operating conditions of the process in nanoscale. Project work corresponds perfectly with the European policy of research directions. New hybrid oil additives that reduce friction and thus fuel consumption are part of a clean energy strategies and lifecycle thus maintaining the momentum for a global green recovery. Moreover, once the production methods have been refined and theoretically described, the use of a jet reactor for synthesis allows the results of this project to be transferred to an industrial scale by multiplying reactors.