Creating graphene-based nanostructures via sustainable mechanochemistry for adsorption removal of volatile organic compounds

Air pollution is a serious issue, especially in the developing world, because of its destructive effect on human health and the environment. Volatile organic compounds (VOCs) are a vast group of organic chemicals (including benzene, toluene, xylene, styrene, hexane, tetrachloroethylene, acetone, acetaldehyde, formaldehyde, isopropanol) that easily enter the atmosphere and are among major air pollutants. VOCs cause photochemical reactions, inducing photochemical smog and ozone destruction, contributing to global warming. Besides, many of them are highly toxic, mutagenic, and carcinogenic compounds. Unfortunately, their concentration in the air is gradually increasing, and thus, immediate treatment is required. Removal of VOCs via adsorption processes on specifically designed nanomaterials is regarded as the most preferable solution due to high efficiency, low cost, possibility of regeneration, and feasibility to implement the technology at large scale.

In the 21st century, graphene and its derivatives have become among the most preferred and promising nanosized carbons in diverse research fields due to their high porosity, tailorable functionalities, layered nature, and remarkable physicochemical properties. Conventional synthesis methods of graphene-based materials are usually time- and energy-consuming and contribute to excessive use and accumulation of toxic solvents. In particular, nanomaterials proposed for environmental applications should be synthesized respecting green chemistry concepts, i.e., using sustainable precursors, safe and nonhazardous chemicals, facile and energy-efficient synthesis procedures. For instance, a scalable and sustainable synthesis of graphene-based porous materials can be performed via a mechanochemical method (ball milling). **This project will implement facile ball milling synthesis strategies to create graphene-containing materials for efficient adsorption of volatile organic compounds, such as benzene, toluene, xylene (known as BTX), styrene, hexane, formaldehyde, acetaldehyde and acetone.**

The project's main objective is to synthesize novel, graphene-containing sorbents with high adsorption capacities for VOCs from inexpensive carbon precursors such as low-quality graphite and additionally different waste materials (such as resins, plant precursors, selected furniture and food wastes). Except for the high adsorption efficiency and reusability of the synthesized products, the important aim of the research will be to implement the concepts of green chemistry as effectively as possible in the synthesis of these advanced nanoporous materials. The obtained graphene materials may also be attractive from the viewpoint of other applications, e.g., hydrogen production and storage, methane storage, carbon dioxide capture, water treatment, etc. It seems essential to enable the vast use of cheap, ecological graphene-based materials.