WORKSHOPS PLAN

TASKS

Task 1. Discussion of Work Safety Rules.

Before the workshops begin, participants will be familiarized with the work safety rules applicable in laboratories and at workstations. Procedures for handling emergencies, accidents, and the use of laboratory equipment will be discussed.

Task 2. Getting acquainted with workstations in The Laboratory of Technological Processes.

Participants will have the opportunity to tour The Laboratory of Technological Processes. During this visit, they can familiarize themselves directly with the workstations and observe the technological processes. They will have the opportunity to observe the work of specialists and learn how various devices and tools are used to conduct research and experiments.

Task 3. Preparation of masterbatches — mixing polymer matrix with POSS compounds on a laboratory rolling mill.

Participants will have a unique opportunity to learn about creating advanced polymeric materials in a polymeric matrix with functional additives — silsesquioxanes. During this part of the workshops, participants will be able to familiarize themselves with mixing and combining ingredients to obtain a homogeneous mixture using the **VM-150/280 Zamak Mercator laboratory mill**. Through an experimental approach, they will be able to observe the impact of various process parameters, such as mixing time or temperature, on the properties of the final product.

Task 4. Grinding polymer masterbatch and natural fiber fillers.

Participants will grind polymer mixtures using the appropriate laboratory mills. During the workshops, participants will look at various grinding process parameters, such as time, rotational speed, type of tool used, and size of the starting material, and understand how they affect the final quality and properties of the material.

Task 5. Injection molding of composite samples.

During this stage, participants will use the injection technique to create composite samples using a previously prepared masterbatch. This process will be carried out on a column-free **Engel e-victory 170/80 injection molding machine** with an electric drive of the injection unit. This stage of the workshops will include the injection process to obtain standardized shapes for further material testing, parameter adjustment, and quality control of the obtained samples.

Task 6. Extrusion of polymer films with POSS additives.

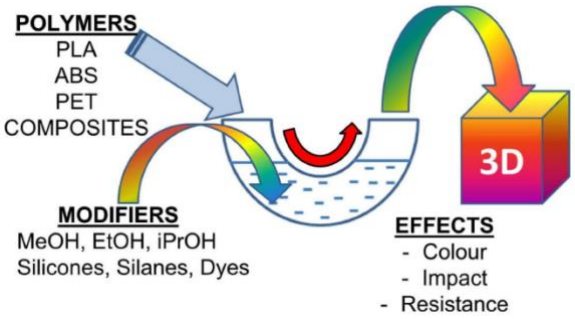
Participants will participate in the process of extruding polymer foils with POSS additives, using a modular set of processing-measurement devices for extruding thermoplastic materials **Haake PolyLab OS (Thermo Scientific) — single-screw extruder Rheomex 19/25**. Extrusion methods, process parameters, and quality control techniques will be discussed.

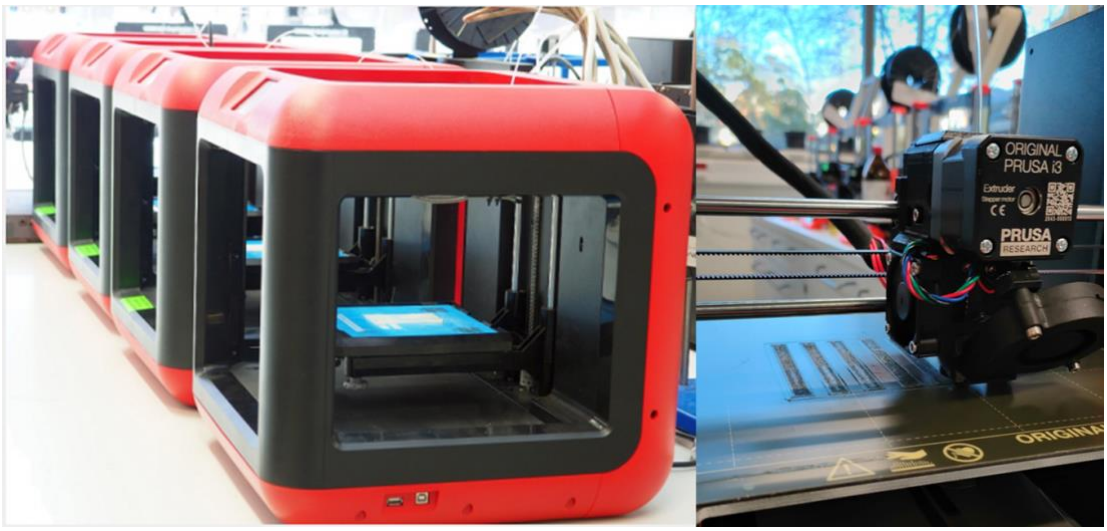
Task 7. 3D printing of elements from polymers containing POSS.

During this workshop session, participants will be introduced to additive manufacturing technology — 3D printing, where they will utilize advanced technologies to create polymer elements with the addition of POSS compounds. Throughout the workshop, participants will have the opportunity to go through all stages of creation, starting from designing elements using appropriate computer programs. Subsequently, they will familiarize themselves with 3D printing techniques and printer operation. In practice, they will observe the process of creating polymer elements, controlling printing parameters, and monitoring the quality of the resulting prints. In addition to the printing process, participants will acquire skills related to quality control of the obtained prints. They will have the opportunity to assess the precision of execution, surface quality, and other significant parameters that affect the final performance and durability of the printed elements.

An LFDM technology demonstration will show the L-FDM technique enables the direct introduction of chemicals, dyes, radioactive substances, pesticides, antibiotics, nanoparticles, trace elements, fertilizers, phosphors, monomers for polymerization, proteins, peptides, and active ingredients in the direct printing process from a polymer material with a typical FDM printer. With the proposed technology, it is now possible to introduce chemical substances into polymer filaments that were previously impossible to apply due to undergoing physical or chemical transformations during previous processing processes.

This article discusses methods that eliminate the need for costly and energy-consuming processing equipment. Users can utilize these methods in any laboratory without access to specialized devices.

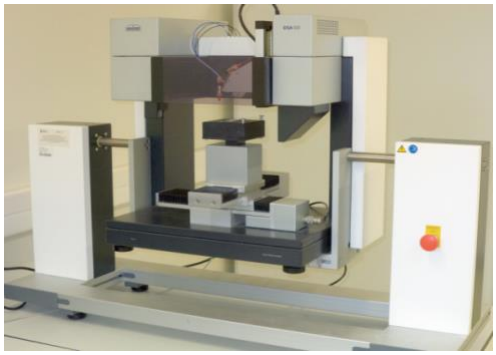




Task 8. Plasma treatment of polymer surfaces and testing the contact angle of the obtained samples.

As part of the scientific workshops, participants will be able to familiarize themselves in detail with the process of plasma surface treatment of polymers using a compact plasma handheld device, **PiezoBrush PZ3**. This technique significantly improves adhesion and optimizes surface properties, crucial in many industrial and research applications. Participants will be able to observe and analyze the impact of using this method and determine how this process affected the surface properties examined in the next stage.

During this stage of the workshops, each participant will receive a set of previously prepared material samples, on which they will conduct independent experiments focused on measuring the wetting angle. This process is necessary to assess the surface properties of materials, such as hydrophobicity or hydrophilicity. Participants will use advanced measuring equipment, the **Krüss DSA100E goniometer with DSA4 software**, to precisely determine the contact angle of a liquid droplet with the material surface. These results will allow for a deeper understanding of the interaction between the liquid and the material, which is crucial for further applications of the studied materials in various fields of science and technology. Additionally, sessions are planned during which participants can exchange experiences and discuss the impact of the obtained results.



Task 9. Microscopic observations 3D printing and injection molding samples.