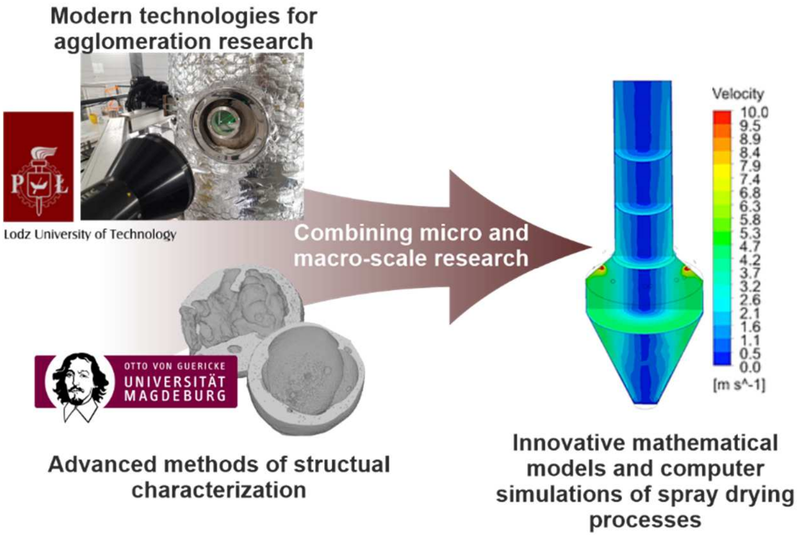
Spray drying is the leading technology for producing a stable bulk solid material from a liquid by rapidly removing its volatile components using hot gas. This technology is widely used in various industries such as chemical, pharmaceutical, and food. Powdered milk, instant coffee, yeast, aromas, and washing powder are the most popular of the wide range of spray-dried products used in everyday life. The attractiveness of these products to customers is attributed to their end-user properties such as wettability, dispersibility and solubility. Key parameters that remarkably impact these properties are the size and size distribution of particles. If particles are too small or the particle size distribution is too narrow, they may create structures difficult to moisten and dissolve. Therefore, it is necessary to combine small particles to form relatively large stable agglomerates in which the basis particles are still distinguishable. In spray drying, this process is typically conducted by recycling dry fines (dust) into the drying chamber, which ultimately increases the yield and prevents the particle size distribution from shifting to too low values. However, this method of agglomeration is limited because considerable size enlargement by actively initiated and controllable agglomeration cannot be achieved by this method.



The primary aim of this project is to determine experimentally and numerically the mechanisms which are responsible for agglomeration in spray drying with a return of fines to the drying chamber. We will answer the following two main questions: Which configuration of the spray dryer can lead to the production of large agglomerates with stable structures? Under which operating process parameters can such agglomerates be produced?

To answer these questions, we will bring two partners, i.e. the Lodz University of Technology (TUL) and the Otto-von-Guericke Universität Magdeburg (OVGU). Both partners are well known at the international level for their contributions to the study of structure development and particle formulation using single droplet evaporation experiments and spray drying technology. Specifically, we will combine the advantages of both microscale single particle analysis and large-scale laboratory spray dryer system, offering a complex multi-scale approach.

Analysis of drying rate with the use of an acoustic levitator and changes in morphology at the level of single particles with the help of different imaging techniques (such as X-ray tomography) for which the German team is famous. Determination of continuous and disperse phase flow dynamics using advanced measurement techniques (such as laser diffraction analysis of particles) during spray drying is the Polish team's core expertise.

As part of the theoretical part of this project, an innovative mathematical model of particle agglomeration associated with kinetic models of drying and morphological changes will be developed by both teams in order to describe the mechanism of agglomeration during counter-current spray drying with the return of small product fractions.

Summarizing, in the frame of a multiscale approach, the proposed research will allow us to identify crucial mechanisms involved in agglomeration by recycling dry fines.