Centre for Sustainable Chemical Technologies

UNIVERSITY OF BATH

Centre for Sustainable Chemical Technologies; University of Bath

Project Title:	Rapid additive and solvent screening for morphology control in continuous crystallisation via machine learning.
Lead Supervisor:	Dr Bernardo Castro Dominguez (Department of Chemical Engineering)
Co-Supervisor:	Professor Chick Wilson (Department of Chemistry)
Industrial Partner:	CMAC Future Manufacturing Research Hub

Project Summary

Particle morphology significantly contributes to the bulk properties of crystalline solid-state materials, influencing downstream processing in pharmaceutical manufacturing, such as flow, compaction, disintegration, bioavailability, etc. Particle morphology is the result of the crystal different growth rates of individual crystal faces during crystallisation. This growth rate can be activated or deactivated by introducing solvents and/or additives that contain molecules and functional groups that interact with the crystal. However, the design of such growth modifiers often relies on trial-and-error and requires extensive screening that consumes time, resources and that are restricted by experimental conditions. As a smarter approach for solvent and additive screening, this project will utilise machine learning to rapidly predict the performance of crystal modifiers. In machine learning, (with enough data and a learning algorithm) the rules that underlie the behaviour of molecules and physical phenomena can be identified by assessing a portion of a dataset and building models to make predictions. As a consequence, the aim of this project is to investigate the effect of additives and solvents for the control of morphology in continuous crystallisation. This will be achieved by experimentally screening various active pharmaceutical ingredients (APIs), solvents and additives, while simultaneously developing a machine-learning platform that can be used as the baseline to predict the morphology of materials crystallised using modifiers. The PhD project will require generating, collecting and processing the data needed required by the machine-learning algorithm. The platform (see bottom right) will be developed in MATLAB's Statistics and Machine Learning Toolbox.

Sustainability issues addressed

Using machine learning to predict the performance of crystal modifiers will make the manufacturing process more efficient and therefore more sustainable. Also, predicting the performance of crystal modifiers will enable the pharmaceutical industry to screen them in a more environmental and sustainable manner, significantly reducing solvent/material usage as well as human resources.

Machine learning for additives and solvent screening

Data collection

- CSD Database
- Crystallographic open database
- ChemSpider
- NIST Materials Data Repository
- Experiments, etc.

Representation

- API (polarity, functional groups, etc.)
- Solvent (polarity, functional groups, quantity, etc.)
- Modifier (polarity, functional groups, quantity. etc.)
- Conditions (temperature, composition, etc.)
- Unit cell
- Space group
- Polymorph type
- Cell volume
- Morphology descriptor

Learning

- Kernel-based learning method
- Neural Network