

International Fine Particle Research Institute

Project Brief

Understanding Caking and Aggregation of Heterogeneous Powders

Caking and aggregation in powders during storage and transport are persistent challenges across a wide range of industries. While the mechanisms underlying caking in purely crystalline or amorphous systems are relatively well-established, most industrial powders exist as complex blends of both phases. The interactions at the amorphous–crystalline interface, and their contribution to time-dependent caking behaviour, remain poorly understood.

This project aims to develop a mechanistic and time-resolved understanding of caking and aggregation phenomena in hybrid amorphous–crystalline systems. By elucidating the physicochemical interactions that govern moisture uptake, thermal effects, inter-particle bonding, and structural consolidation across phase interfaces, we will expand the current domain of knowledge beyond idealised systems.

This work builds on the conclusions of Jamie Clever’s 2008 IFPRI review on powder caking, which emphasized that formulations of ductile and brittle materials—representing amorphous and crystalline phases—remain poorly understood. We aim to extend this foundational work by providing new insights into the coupled behaviour of these mixed-phase systems and enabling more robust powder product design and control.

The objectives of this project include:

- Characterise the time-resolved caking and aggregation behaviour of mixed amorphous–crystalline powder systems under controlled storage and transport conditions, particularly under varying moisture and temperature conditions.
- Identify and model the mechanistic interactions at the interface of amorphous and crystalline phases that drive moisture-induced bonding and consolidation.
- Develop predictive tools and design guidelines to mitigate caking in hybrid powder formulations, enabling improved handling, flowability, and product stability.

Emphasis should be placed on isolating the moisture, thermal and chemical interactions at the phase interfaces, with the goal of understanding how increasing crystallinity or amorphicity impacts time-resolved consolidation under realistic storage and transport conditions.