

IFPRI Project Brief

High Throughput Measurement of Particle Jamming

The point at which jamming occurs determines the maximum solid loading in the creation of highly filled wet system, from chocolate to ceramics, and probably plays a key role in understanding the process of reconstituting materials from powders and liquids. It is a key measurement and important in the creation of highly filled, dense systems. Theoretical and experimental work from the Edinburgh group has also shown that friction-induced jamming in non-Brownian suspensions also controls their granulation behavior. Knowing the solid volume fraction, Φ_j , at which jamming occurs and how it depends on particle properties and processing conditions is therefore of key importance.

Nevertheless, Φ_j is seldom measured outside academic research, almost certainly due to the lack of a high throughput measurement (HTM) method for doing so. Currently, it is typically determined by measuring the high-shear viscosity at multiple volume fractions which requires a lot of material, is time consuming, and requires expert loading of samples into a rheometer to ensure sample homogeneity.

Creation of a high throughput measurement would allow widespread take-up of measuring Φ_j as a key characterization step in all industries creating and processing pastes. This should help explain materials, prevent issues, influence production techniques, and troubleshoot problems. Availability of such a method should also allow the science-guided design of particle properties to manipulate the reconstitution process and the properties of the final product, potentially revealing gaps in current characterization methodologies for these properties.

The objectives of this project include:

- Develop one or more high-throughput, rapid methods for the measurement of the particle jamming fraction without the need to determine $\eta(\phi)$ from multiple samples
- Validate the method(s) for a broad range of starting materials, perhaps through a round-robin exercise.
- Use the method(s) to screen particle properties (roughness, shape, particle chemistry, matrix properties) that impact particle jamming and create models for understanding how such dependence arises.

The scope includes particles ranging from submicron to approximately 200 μm (i.e., Brownian and non-Brownian systems), exclusively highly filled systems, and polydisperse and multicomponent systems (as a stretch goal).