IFPRI Project Abstract

Adhesion of powders to metal surfaces during compaction

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Project Objective:

This project aims to develop a fundamental understanding and predictive relationships between a powder's physical and chemical properties and its propensity to adhere to metal surfaces of compaction tooling.

Approach:

Sticking hypotheses:
1. Temperature. Sticking can be understood as a coupled thermo-mechanical problem with two sources of heat: dissipative processes during compaction and friction between powder and tooling. The materials and surfaces evolve, e.g. phase transformations due to stress, strain rate, temperature. Currently the project is focused on temperature.
2. Humidity. Moisture uptake by hygroscopic materials leads to water acting as a binder at the interfaces, leading to sticking.
3. Particle breakage. Brittle materials or granules break during compaction, creating new surfaces. These new unlubricated surfaces give cohesion/strength to compact but also lead to sticking.

Recent Results:

The project has effectively started in August 2021 with PhD student Ahmad Ramahi and PhD student Vishal Shinde joined in February 2022. We aim to finish the project by the renewal date, AGM 2023. We hold monthly meetings with IFPRI members which are extremely informative.
WP1: Identification of test materials and characterisation procedures – complete.
WP2: Characterisation of single component materials and surfaces. PSD – Malvern 3000 (wet), AFM for surface energy and surface roughness. AFM Kelvin Probe (surface potential) developed as method to observe sticking.
WP4: Redesigned heated die and trilayer (metal disk-tablet-metal disk) system. Characterised Ibuprofen, Paracetamol and Mannitol.
Identified strain rate as a new potential parameter responsible for sticking.

Next Steps:

- Characterise: aspirin, maize starch, sorbitol, 2 lactose grades, MCC.
- Nano-indentation, DSC and surface composition (EDX – SEM) analysis.
- AFM with particle probe requires method development.
- Rotary friction system requires redesign.
- Establish predictive criteria for sticking propensity.